THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 48 JULY, 1942 No. 1

THE ROENTGENOLOGICAL APPEARANCE OF EXTRAMUCOSAL TUMORS OF THE ESOPHAGUS

ANALYSIS OF INTRAMURAL EXTRAMUCOSAL LESIONS OF THE GASTROINTESTINAL TRACT IN GENERAL*

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THE common tumor of the esophagus is carcinoma arising from the esophageal mucosa. Tumors of the esophagus which do not involve the mucosa are rare: fibroma, myoma, lipoma, neurofibroma, leiomyosarcoma, myxofibrosarcoma, and cyst have been described.

Most reports in the literature on these lesions are descriptions of clinical cases and of postmortem specimens. Roentgenological observations have been few and the majority of them have been concerned with pedunculated tumors, i.e. pedunculated fibroma, myxofibrosarcoma and leiomyosarcoma.

In this report, we shall confine ourselves to such lesions which are not pedunculated but grow within the wall of the esophagus by spreading its layers apart. We have been able to find in the literature only 4 cases examined roentgenologically which belong to this group. Pape and Spitznagel[4] described an intramural myoma of the lower end of the esophagus; Menne and Birge,[3] a leiomyosarcoma of the middle third of the esophagus; Barrett,[1] a fibroma at a similar level. A correct diagnosis as to the layer or layers of the esophageal wall involved was not made in the first 2 cases; the location of the tumor was undecided in the last case. In the fourth case (Beutel[2]) only esophagoscopic control was obtained and a cyst was assumed.

We have seen 6 cases which belong in the above mentioned group. In 3 of these the diagnosis was confirmed by operative removal of the lesions which were found to be cysts in 2 of the cases and a neurofibroma in the third case. The other 3 cases could not be classified histopathologically inasmuch as only esophagoscopic control was obtainable.

The main reason for reporting these cases is, however, not their rarity. We have used these cases to study a rather neglected group of lesions of the gastrointestinal tract. The lesions in this group are characterized by the fact that they are located in the wall of the intestine below the mucosa. In other words, they are intramural extramucosal lesions of the gastrointestinal tract. As a group, they are by no means rare.

We have tried to analyze the characteristic roentgenological features of these

* Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1942.

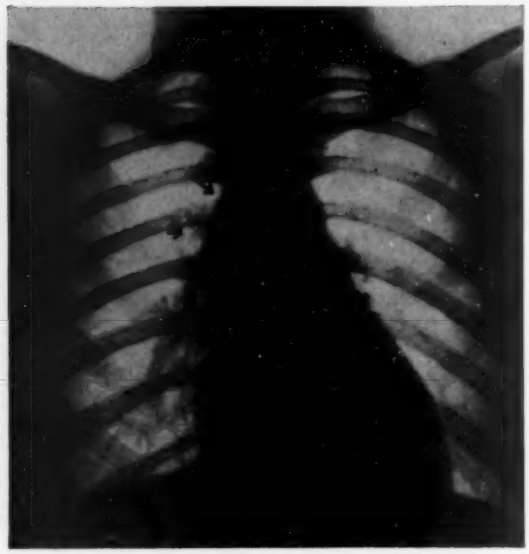

FIG. 1. Case 1. Neurofibroma within the wall of the esophagus. There is a soft tissue mass to the right of the great vessels.

lesions and to differentiate them from mucosal lesions, on the one hand, and from extrinsic, extramural lesions, on the other hand.

CASE REPORTS

CASE 1. M. W. (No. 36732*) (Fig. 1 and 2). This girl, aged nineteen, had had for two years intermittent attacks of dull, non-radiating pain beneath the lower sternum lasting two to three days; thereafter, she remained symptom free for a month or more. The pain was more apt to occur after meals and often awakened the patient at night. For six months, the pain had become more frequent, colicky and severe enough to double her up. On two occasions, she vomited during an attack of pain. For eight months, the swallowing of bulky foods had been difficult; she had lost 10 pounds in weight. Physical examination was essentially negative.

Roentgenological Examination. An oval, slightly lobulated soft tissue mass was found lying to the right of the midline between the aorta and the spine from the fifth to the eighth dorsal vertebra. This mass protruded into the lumen

* This case appeared in the Case Records of the Massachusetts General Hospital, Case No. 23491, *New England J. Med.*, 1937, *217*, 955–958.

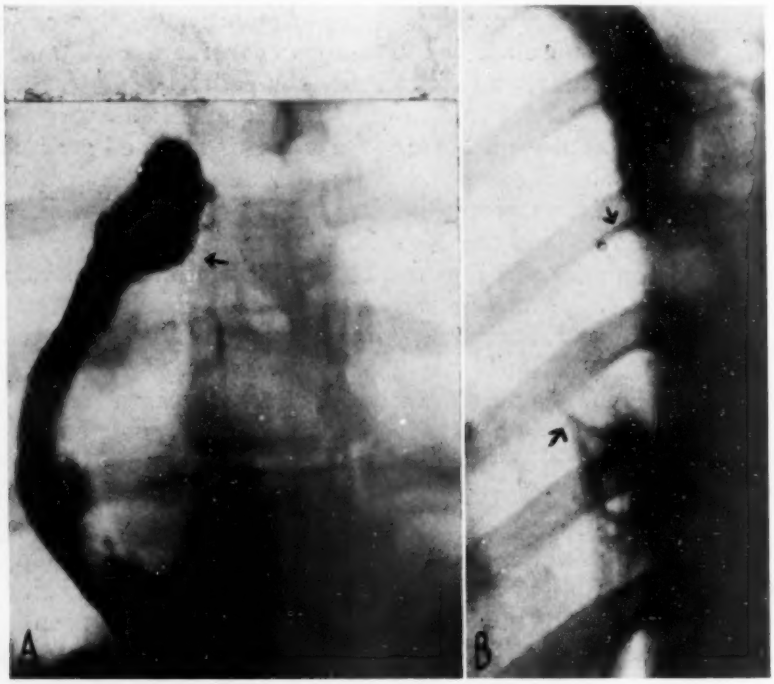

FIG. 2. Case 1. *A*, the barium-filled esophagus is displaced by the right-sided mass to the right, and not to the left as one would expect. The esophagus is closely related to the mass. Note the abrupt angles (arrows) where the esophagus meets the upper and lower poles of the mass. *B*, face-on view shows the sharply defined edge of the protruding tumor.

of the esophagus and had a smooth surface. At times, normal mucosal folds were visible in the region of the mass (i.e. the folds of the opposite wall). The upper and lower edge of the filling defect formed sharp corners with the uninvolved portion of the esophagus, and in the face-on view the lesion was as sharply defined as a mucosal lesion.

Preoperative Conclusions. There is a tumor firmly attached to and probably arising within the esophageal wall. The mucosal surface of the esophagus is probably not involved by the tumor.

At operation (Dr. E. D. Churchill), a well encapsulated neurofibroma arising in the wall of the esophagus was shelled out and dissected from the outer surface of the mucous membrane.

Comment. A neurofibroma arising in the wall of the esophagus produced a characteristic roentgenological appearance. It corresponds to the picture published in Barrett's case report of an intramural fibroma of the esophagus. So far as we know, our case represents the first report of roentgenological observations in an intramural neurofibroma of the esophagus.*

Case II. P. S. (No. 159525) (Fig. 3).

This woman, aged twenty-six, had had for six months intermittent attacks of vomiting and regurgitation of bulky foods immediately after swallowing. These attacks lasted one to three days; then she could swallow normally for a few days. Salivation was increased during an attack.

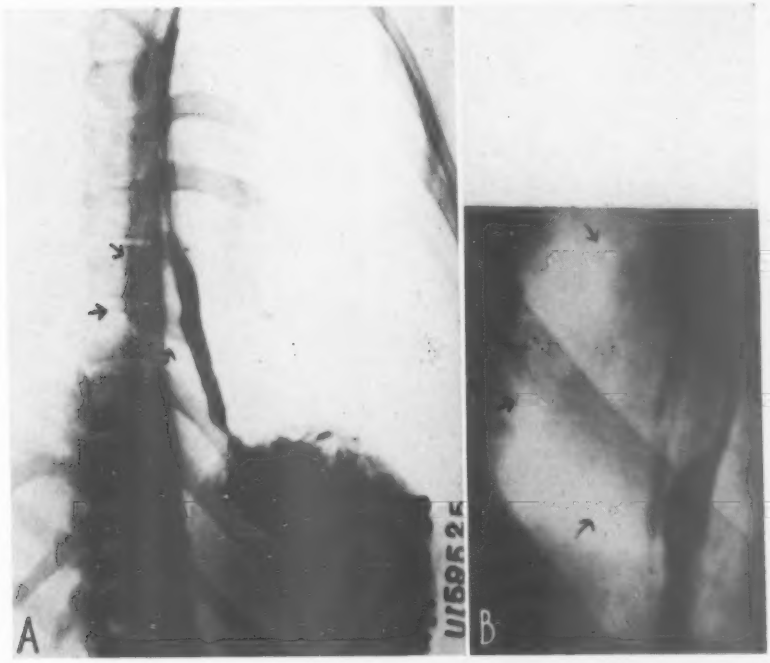

Fig. 3. Case II. Bronchogenic cyst within the wall of the esophagus. *A*, note the soft tissue mass. *B*, spot film shows marked intraluminal protrusion, more than would be expected with a small extrinsic tumor. The normal mucosal folds of the uninvolved opposite wall are clearly visible.

On one occasion, she vomited three tablespoonfuls of dark red blood. Gradually a sensation of pressure beneath the mid sternum developed. An ulcer of the esophagus had been diagnosed elsewhere. On admission, physical examination was essentially negative.

Roentgenological Examination. There was a round mass in the posterior mediastinum 1 inch in front of the eighth dorsal vertebra and 3.5 cm. in diameter. This produced a well rounded pressure defect on the right border of the esophagus, having an acute, sharply defined angle with the rest of the esophagus. The mucosal

* Since this paper was presented a case of neurofibroma of the esophagus was published by K. Kornblum and H. H. Bradshaw, *Radiology*, 1941, *37*, 391–406.

folds were preserved. The mass moved with the esophagus on breathing and swallowing. At times, the mass was thought to change slightly in shape during respiration but this finding was not conclusive.

Preoperative Conclusions. There is a small intramural extramucosal tumor of the esophagus which might be an intramural leiomyoma or an intramural neurofibroma.

In order to rule out the unlikely possibility of lymphoma, roentgen irradiation, 600 r, was given over an anterior and a posterior chest field without any subsequent change in the size of the mass.

At operation (Dr. E. D. Churchill), a slightly lobulated cyst was shelled out of the muscular wall of the esophagus. It measured 0.8 by 1.6 by 1.0 cm.; its wall was 2 mm. in thickness and was composed of muscle bundles, dilated glandular spaces lined with ciliated epithelium, mucous glands and cartilaginous plates. The final anatomical diagnosis was intramural bronchogenic cyst (Dr. T. B. Mallory).

Comment. A small intramural extramucosal tumor was diagnosed roentgenologically. It proved to be an intramural bronchogenic cyst. This is—as far as we can discover—the first reported and proved roentgenological observation in a case of intramural cyst of the esophagus.

Case III. H. L. (No. 246015*) (Fig. 4 and 5).

This man, aged forty-two, had had an increasingly severe, brassy, non-productive cough for two years. For one month, following a cold, there had been an aching sensation beneath the sternum relieved by standing or lying on his side and increased by lying on his back. Roentgen studies elsewhere had shown a mass in the mediastinum. Three roentgen treatments had not reduced the size of this mass. Physical examination revealed a slightly obese man with an occasional hard cough.

Roentgenological Examination. There was a round mass in the posterior mediastinum about 10 cm. in diameter extending from the fifth to the ninth dorsal vertebra. This mass displaced the esophagus backward, flattened it markedly

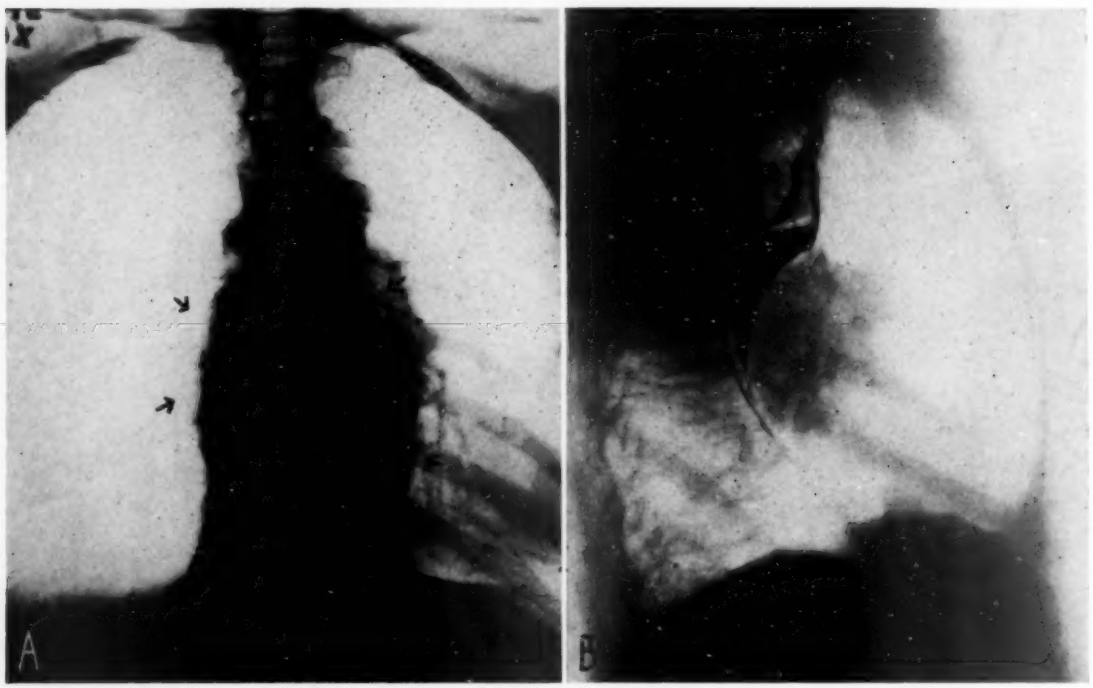

Fig. 4. Case III. Large cyst within the wall of the esophagus. *A*, anteroposterior Potter-Bucky view. *B*, the esophagus is displaced posteriorly and closely related to the tumor.

* This case appeared in the Case Records of the Massachusetts General Hospital, Case No. 26291, *New England J. Med.*, 1940, *223*, 105–108.

in the anteroposterior diameter but widened it in the transverse diameter. The mass was intimately adherent to the esophagus and moved with it during swallowing. In the lateral view the mass produced a sharply defined angle at the junction of the flattened displaced portion with the remainder of the esophagus. A definite edge could be seen in the anteroposterior view. The surface of the mass was smooth, and the mucosa appeared intact. The carina was spread apart, and the left main bronchus markedly narrowed by the tumor resulting in collapse of the left lower lobe. Examination in the upright and horizontal positions had no influence on the size and shape of the mass.

Preoperative Conclusions. A large mass is situated between the heart and the esophagus with the carina lying across the superior pole of the mass. The mass is intimately connected to the esophagus either by adhesions or by the fact that it arises within the esophageal wall outside the mucosa. A definite differentiation between these two possibilities is not thought possible, though it seems more likely that the mass is merely adherent to the wall. A cystic tumor is more likely than a solid one. This might be a cyst arising from the left main bronchus.

At operation (Dr. E. D. Churchill), a large cyst was found between the aorta and the left lung. The muscular coat of the esophagus was spread out over the cyst, so that in its removal a considerable area of the under surface of the esophageal mucous membrane was exposed. The most adherent part of the cyst was at the carina of the trachea. It was thought possible that a fibrous cord, found in this region, might represent the origin of the cyst. The left lower lobe was found to be collapsed.

The cyst could not be classified histopathologically.

Comment. A large mass was demon-

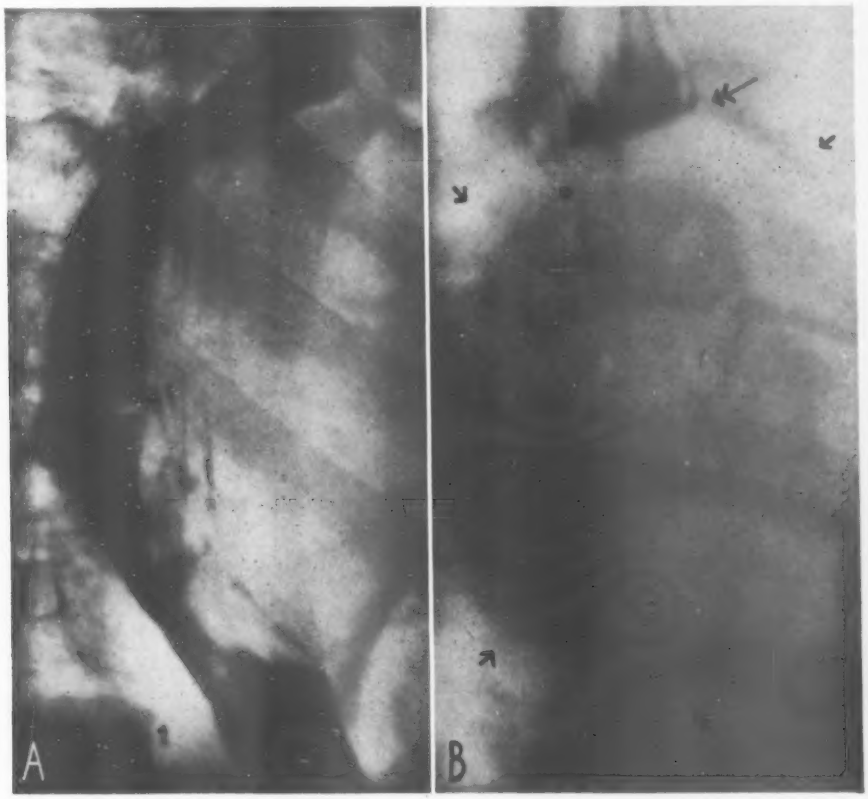

Fig. 5. Case III. Cyst within the wall of the esophagus. *A*, barium partially fills the slit-like esophageal lumen and produces a "smear effect." *B*, anteroposterior view demonstrates the abrupt beginning and ending of the filling defect at the edges of the tumor (double arrows; single arrows outline the tumor mass).

strated roentgenologically closely attached to the esophagus and left main bronchus. At operation, a cyst was found adherent to the carina. The wall of the cyst was buried in the muscular layer of the esophagus down to the under surface of the mucous membrane. The exact origin of the cyst could not be established.

CASE IV (Fig. 6). A physician, about thirty-five years old, requested examination of his esophagus because, during the past few months he had had an intermittent unusual sensation beneath the upper end of the sternum during swallowing. There had been no dysphagia. Two previous roentgenological examinations elsewhere had failed to show any pathological condition in the esophagus; the patient's complaints had been thought to be functional in nature.

Roentgenological Examination. There was no obstruction to the flow of barium through the esophagus. A small, sharply defined filling defect was, however, visible on the right anterior wall of the esophagus, just above the point of crossing of the left main bronchus. The defect was slightly lobulated. No ulceration and no soft tissue mass were seen.

Conclusions: There is a small benign tumor of the wall of the esophagus, probably outside the mucosa.

Esophagoscopy. A small mass was seen to protrude into the esophagus. It was covered by normal mucosa. The esophagoscope passed readily by the mass.

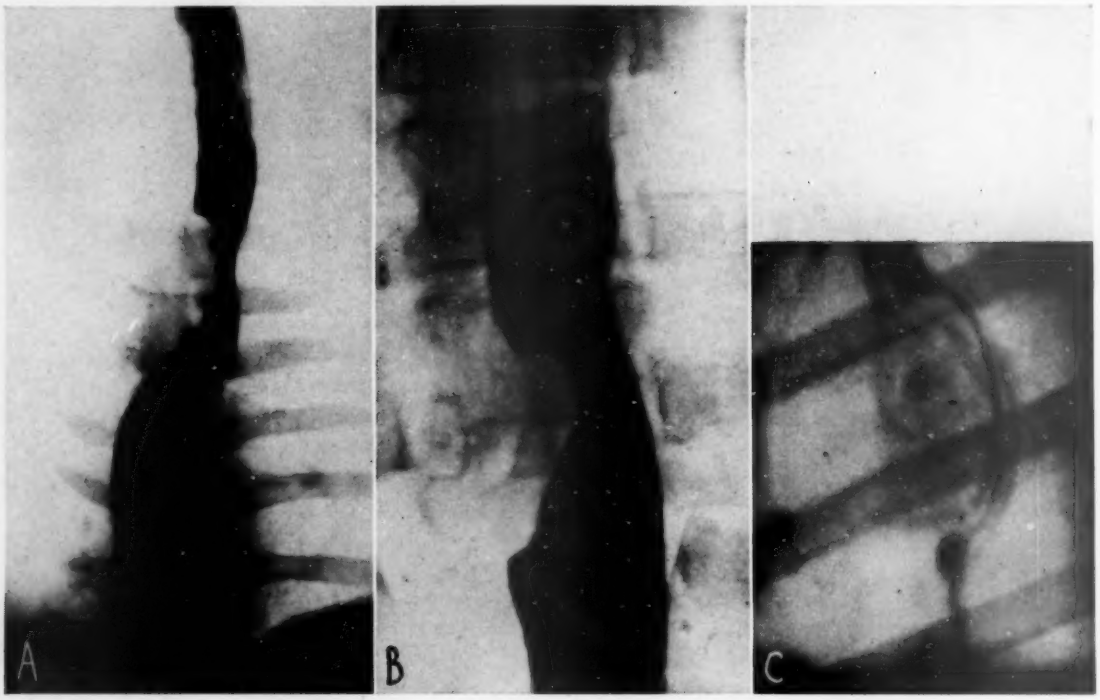

FIG. 6. Case IV. Intramural extramucosal tumor of the esophagus (histopathology undetermined). Sharply defined small filling defect on the right anterior wall of the esophagus; the edges are abrupt; the surface is slightly lobulated but smooth. Note the marked protrusion of the small mass, particularly visible on the evacuation film, *C*.

Repeated roentgenological examinations over a period of two years showed only questionably slight increase in the size of the mass.

Comment. A small intramural extramucosal tumor was diagnosed roentgenologically and confirmed by esophagoscopy. It did not change essentially over a period of two years. No histopathological classification was possible.

CASE V. (This case was included in a previous report[6] but its characteristics were not definitely recognized at that time) (Fig. 7).

A woman, aged thirty-six, was admitted to the hospital complaining of sour eructations, nausea and some pain in the epigastrium unrelated to meals. During the past six months she had lost 10 pounds in weight. Clinical examination showed no variation from normal.

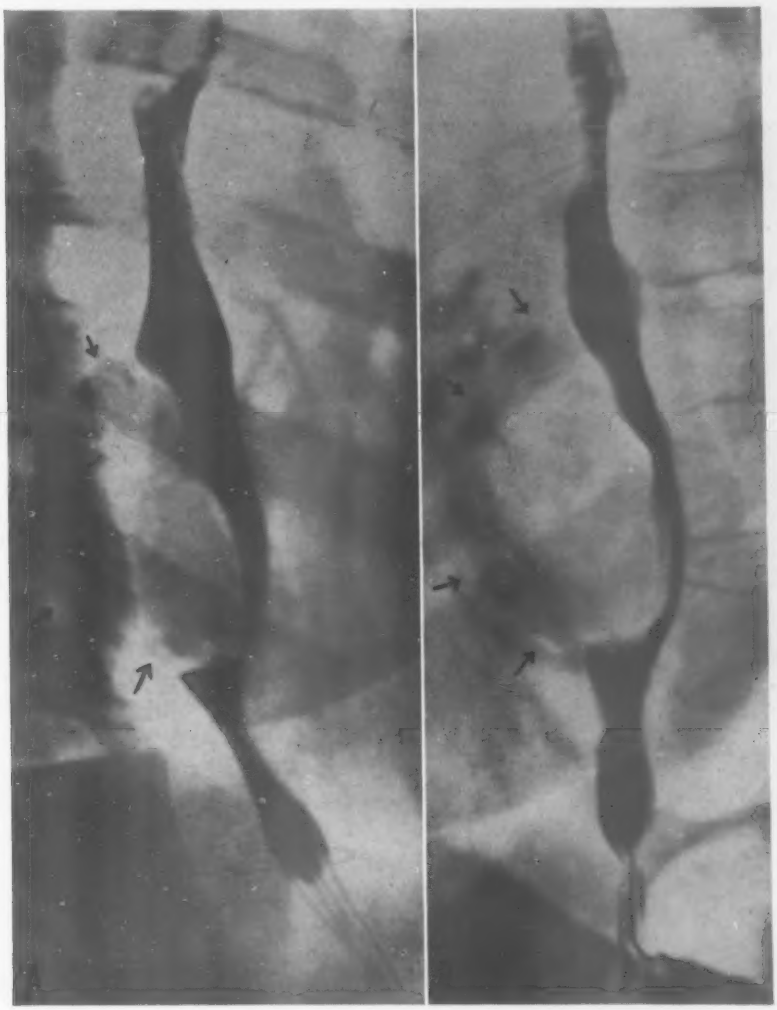

Fig. 7. Case v. Intramural extramucosal tumor of the esophagus (histopathology undetermined).

Roentgenological Examination. A lobulated mass, the size of a hen's egg, was seen in the posterior mediastinum, intimately connected to the esophagus at the junction of the middle and lower thirds. The mass bulged into the lumen which was stretched by the tumor so that it appeared widened when the esophagus was distended with barium. The edges of the lesion were sharply defined in the barium column. Normal mucosal folds were seen in the area involved, apparently representing the wall opposite to the mass. The mass moved with the esophagus during peristalsis and respiration. Conclusions: There is a large tumor intimately connected to the wall of the esophagus. Whether the tumor arises in the wall of the esophagus or has secondarily grown into the esophagus is not decided, but the latter possibility is thought to be more likely.

Esophagoscopy showed a slight, flat protrusion at a distance of 25 to 28 cm. from the incisor teeth. The color of the mucosa in this area was unusually bright; its surface was smooth and marked vascular injection was present. No biopsy was obtained.

The tumor did not respond to roentgen treatment.

Comment. Although not recognized with certainty at the time of examination, this tumor has all the characteristics of an intramural extramucosal lesion. Its borders are abrupt in the face-on view, and they form a sharp angle with the main course of the esophagus. The mass moves with the esophagus during respiration and peristalsis. That an extrinsic mass could have been attached to the esophagus to such an extent by adhesions or actual growth is highly unlikely. The similarity between this case and the proved case (Case I) is striking.

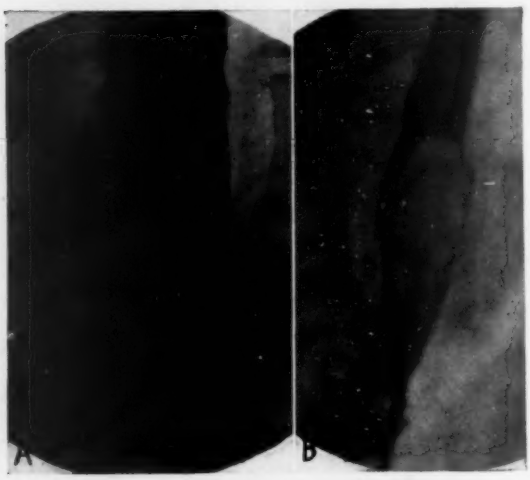

FIG. 8. Case VI. Small intramural extramucosal tumor of the lower end of the esophagus (histopathology undetermined). The tumor is visible only on the relief film.

CASE VI. Like the last case, this case was included in a previous report[6] but its characteristics were not definitely recognized at that time (Fig. 8).

A man, aged fifty-three, was examined because of indefinite epigastric complaints. The examination of the stomach was negative. In the lower end of the esophagus, however, a cherry-sized, lobulated, sharply defined defect was seen. This was visible only during a certain phase of the filling of the esophagus, disappearing and reappearing again at frequent intervals.

Esophagoscopy showed a slight, grayish white, lobulated protrusion. Two biopsies were without success due to the firmness of the small lesion. Re-examination one and one-half years later showed no appreciable change in the size and shape of the mass.

Comment. A small, slightly elevated, well defined tumor was found in the lower end of the esophagus. A soft tissue mass was not visible. The small mass was definitely intramural. The absence of roentgenological ulceration was against a diagnosis of mucosal tumor. This was borne out by esophagoscopy. In other words, this was a small intramural extramucosal tumor. Its histopathology was not established.

DISCUSSION

Our 6 cases had several roentgenological features in common. The profile view, when it was obtainable, showed an abrupt sharp angle where the edge of the tumor met the uninvolved wall of the esophagus. If seen face-on, the lesions were sharply outlined in the relief picture of the esophagus.

The characteristic features of these lesions were obscured when the esophagus was overdistended by too much barium and, on the other hand, too little barium resulted at times in incomplete filling and therewith prevented the accurate demonstration of the type of lesion. The degree of filling which produced consistently the same roentgenological appearance in a given case determined the correct amount of barium to be used. This amount varied from case to case.

A relief picture of the mucosa overlying the lesions was not obtainable due to the stretching out of the mucosa over the smooth surface of the lesions. The mucosal folds of the wall opposite the lesions, however, were visible in a number of instances.

In some cases, the esophagus appeared markedly narrowed in the involved area, yet in spite of this, no obstruction to the passage of barium was seen. As a matter of fact, some of the lesions were visible only at certain moments in the passage of the barium (Cases II, IV and VI) and spot films taken at these moments gave an exaggerated impression of the ease of demon-

strating the lesions. All these findings were easily explained by the fact that the wall of the esophagus opposite to the lesion had retained its normal elasticity and stretched out to allow food or barium to pass.

In the larger intramural tumors, the esophagus was narrowed in one diameter while it was stretched and widened by the tumor in the opposite diameter with a resulting slit-like lumen (Cases I, III and V). A face-on view of this flattened lumen at times showed the barium irregularly distributed over the smooth surface of the tumor producing an inconstant "smear effect" which might easily be misinterpreted as the irregular surface of an ulcerated tumor.

Unless seen exactly in profile or face-on, the distinguishing features of these lesions were at times not recognizable. Oblique views sometimes demonstrated the characteristic appearances of the lesions only at one and not at the other edge but, by rotation of the patient, the characteristic picture was almost routinely demonstrable at both edges.

A definite roentgenological diagnosis as to the histopathology of the intramural lesion was not possible in any of the cases. The presence of lobulation as seen in Barrett's fibroma,[1] in our neurofibroma, and in the myoma reported by Pape and Spitznagel,[4] seemed to be of no diagnostic value. More important would be a change in the shape of the lesion with respiration and peristalsis as apparently seen in our Case II. When this occurs, a cystic tumor may be assumed. This was the only clue we found which might be of help in making a histopathological diagnosis.

EXPERIMENTAL STUDIES

We were not certain how greatly the exact site of the lesion in the wall of the esophagus might influence its roentgenological appearance and whether or not tumors attached to the outside of the esophagus might give an appearance similar to intramural lesions. For this reason, we did a number of experimental studies. Various artificial tumors were placed within and against the walls of esophagi which were used immediately after removal at autopsy. The esophagi were filled with barium sulfate suspension, and the effects of the artificial tumors on the esophagus were studied by roentgenoscopy and spot films.

(*a*) *Submucosal Tumors.* Submucosal tumors were produced by injecting paraffin into the submucosal space. The roentgenological appearance of these lesions was found to be indistinguishable from that seen commonly in tumors of the mucosa. If seen in profile (Fig. 9*A*) the lesions projected into the lumen forming an abrupt angle with the outline of the uninvolved esophagus, above and below the tumor, or in other words, the exact shape of the tumor mass was preserved in the barium cast of the esophagus in spite of the overlying mucosa.

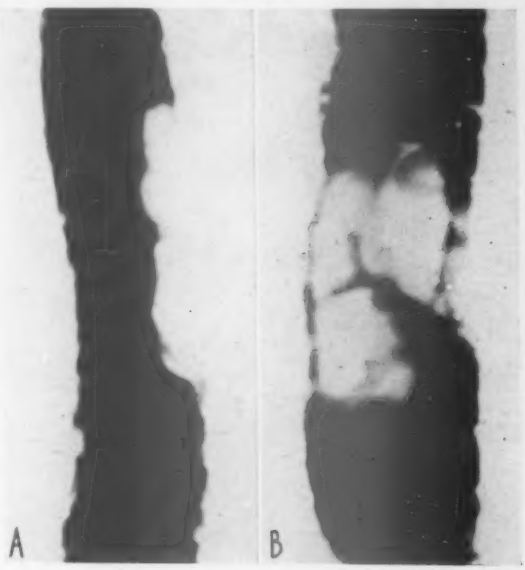

FIG. 9. Submucosal tumor. (Paraffinoma in the submucosa of the small intestine; postmortem study.) Note the sharply defined edges in the lateral view and the sharp border in the face-on view. The appearance is indistinguishable from that of a mucosal lesion. The exact shape of the tumor surface and the exact circumference of the tumor are demonstrated.

If examined face-on, the lesions were hidden in a completely filled esophagus.

With increasing and localized external pressure over the lesions, they become suddenly visible in toto, just as one customarily sees a small cancer of the stomach become visible with a certain amount of manual pressure during roentgenoscopy. In the relief picture (Fig. 9 *B*) a sharply defined filling defect was seen, corresponding to the size and shape of the tumor. At times the normal mucosal folds of the opposite wall were visible running across the tumor defect.

(*b*) *Extrinsic Tumors* (*Unattached*). In order to simulate the effect of extrinsic tumors on the roentgenological appearance of the esophagus, oval pieces of cork were pressed against the esophagus by means of a wooden stick or pencil.

The profile views showed, instead of the abruptly angled corners of the submucosal tumors, a gentle slope which started within the uninvolved area a short distance away from the actual edges of the compressing tumor and extended to the most protruding part of the tumor (Fig. 10, *A* and *C*). In the face-on views, the defects produced by the extrinsic tumors were poorly defined and had blurred edges (Fig. 10, *B* and *D*). In other words, the exact shape of the tumor was not seen due to a cushioning effect of the unattached intervening esophageal wall between the barium and the tumor.

(*c*) *Intramural Tumors below the Submucosa.* It was thought doubtful whether the loose submucosal space alone might have a cushioning effect similar to that of the whole esophageal wall in the unattached extrinsic lesions. For that reason, an artificial tumor was produced below the submucosa and within the muscular coat of the esophagus by inflating a small rubber balloon which had been inserted within this muscle coat. The subsequent roentgenological studies showed that the submucosa, for all practical purposes, did not have such a cushioning effect (Fig. 11). These intramuscular tumors had the same roentgenological characteristics as the submucosal tumors, and not those of the unattached extrinsic tumors.

(*d*) *Extrinsic Tumors* (*Attached*). It was

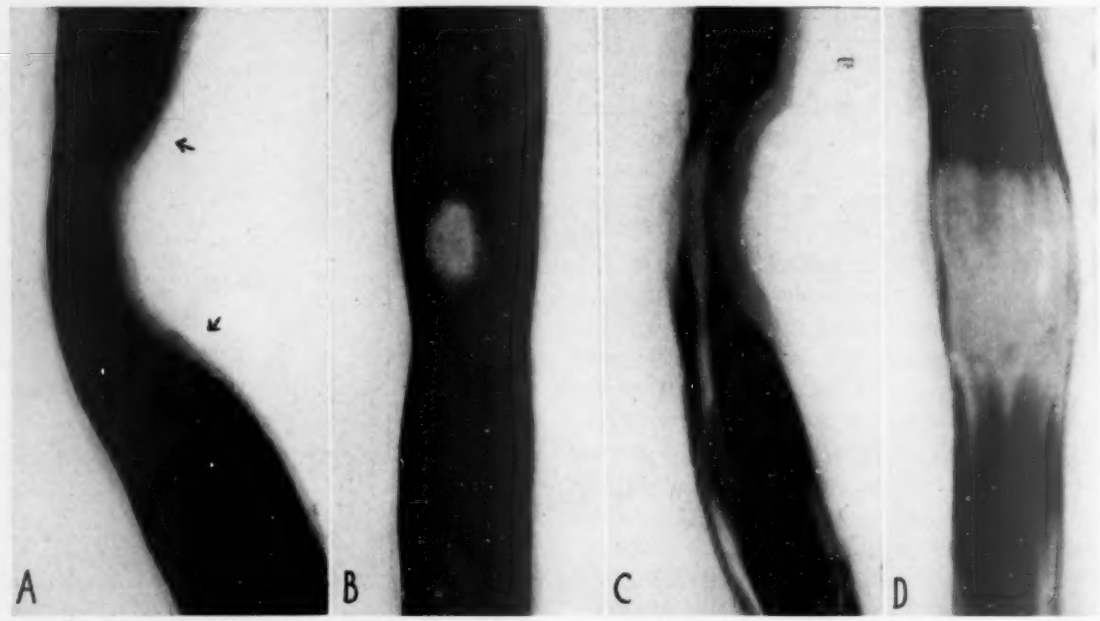

Fig. 10. Extrinsic tumor not attached to the esophagus. (Piece of cork pressing against the wall of the esophagus; postmortem study.) *A*, in the lateral view, there are gentle slopes (arrows) at the edge of the tumor. *B*, in the face-on view, the edges are poorly defined. *C*, *D*, relief demonstration. In contrast to Figure 9, the exact size and shape of the tumor are not visible in the barium-filled esophagus.

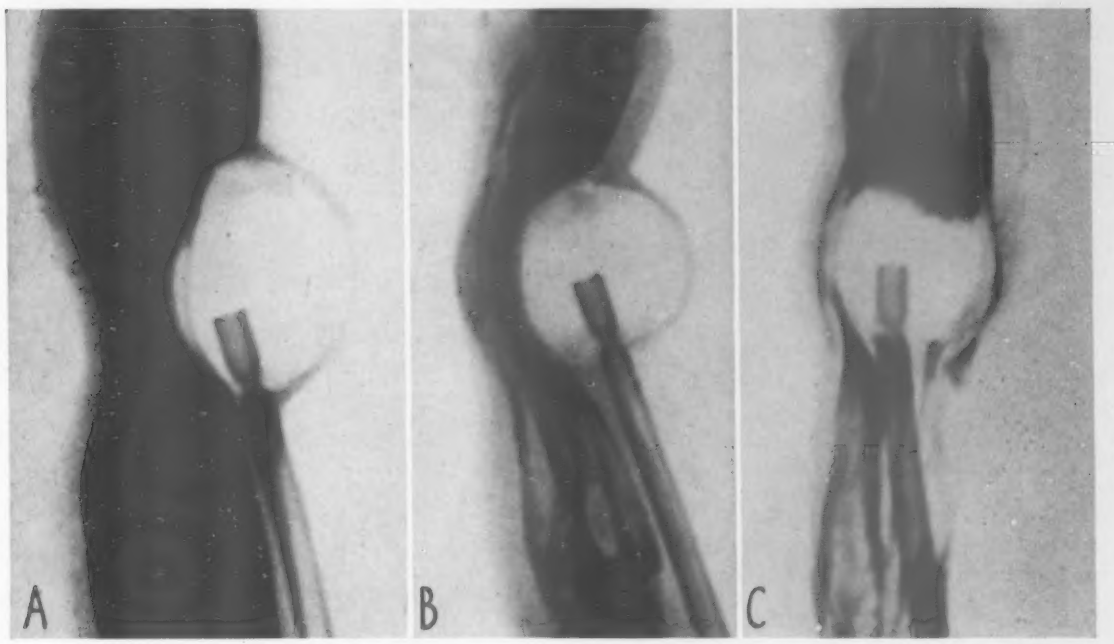

Fig. 11. Intramuscular tumor. (Inflated balloon buried in the muscular layer of the esophagus; postmortem study.) The tumor produces a sharply defined defect, similar to that of a mucosal or submucosal lesion.

thought likely that the attachment of a tumor to the outside of the esophagus, as by adhesions in clinical cases, might change its roentgenological appearance. For this reason a small piece of cork was attached to the outside of the esophagus with sev-

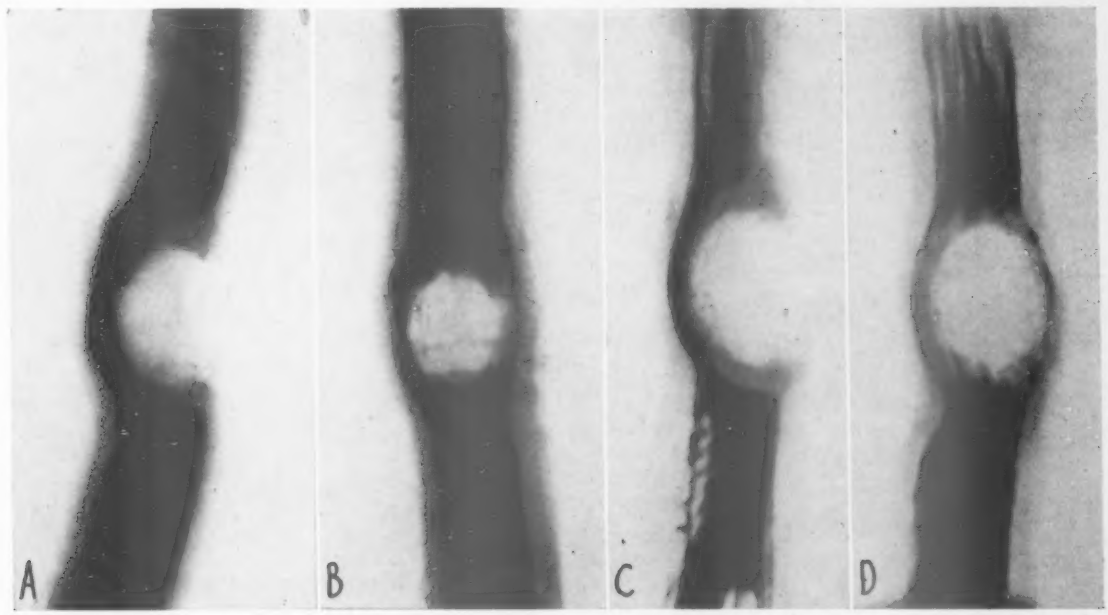

Fig. 12. Extrinsic tumor, completely attached to the esophagus. (Piece of cork, buried in the outside of the esophagus; postmortem study.) When completely attached to the wall, the tumor assumes the characteristics of an intrinsic lesion. Compare with Figure 10.

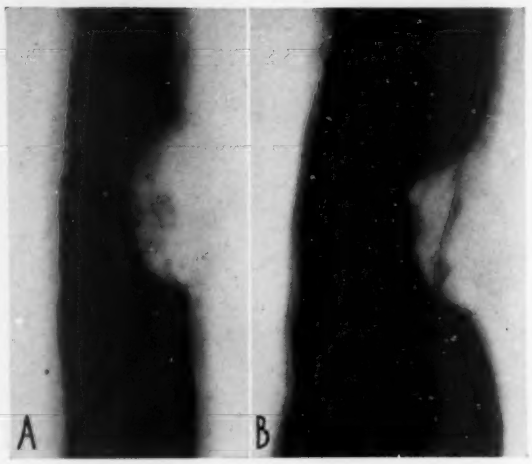

FIG. 13. Extrinsic tumor, partially attached to the esophagus. (Piece of cork, sewed to the esophagus with one-half of its surface; postmortem study.) *A*, "intrinsic" characteristics are produced by the attachment. *B*, with overfilling of the esophagus, "extrinsic" characteristics are brought out above and below the attached area.

eral small sutures until it was completely buried. The sutures passed only into the muscular coat of the esophageal wall. The roentgenological examination showed that, due to this attachment, the tumor had lost its extrinsic characteristics and had acquired the roentgenological appearance of an intramural lesion (Fig. 12).

This metamorphosis also took place when the tumor, instead of being buried completely in the outer wall, was attached to the esophagus by only half of its circumference (Fig. 13).

Of particular interest were artificial extrinsic tumors which were attached to the esophagus at only one pole. Pressure on these tumors from the outside produced more or less clearly the appearance of an intramural lesion at the attached, and that of an extrinsic lesion at the unattached pole of the tumor (Fig. 14).

Summarizing these experimental studies, artificial tumors within the wall of the esophagus, whether they were in the mucosa, submucosa, or in the muscular layer, produced a similar roentgenological appearance in profile and face-on views, regardless of the actual layers in which the tumors were situated. This appearance was characterized by the fact that the defect which the tumors produced in the shadow of the barium-filled esophagus corresponded closely to the shape and size of the actual tumors. Pressure defects due to unattached extrinsic artificial tumors differed from this appearance. Extrinsic tumors when completely or partially attached to the outside of the esophagus assumed the roentgenological features of an intramural lesion in the attached portions of the tumors.

DIFFERENTIAL DIAGNOSIS IN CLINICAL CASES

The preceding experimental studies have shown that the roentgenological appearance of an intramural lesion differs basically from that of an unattached extrinsic lesion. A similar difference does not exist between the roentgen appearance of (1) mucosal, (2) intramural submucosal and (3) attached extrinsic lesions. In the experiments, their roentgenological appearance is the same. Does this mean that it is impossible roentgenologically in a given clinical case to separate from one another these three types of lesions? That this is not true is readily demonstrated by our cases re-

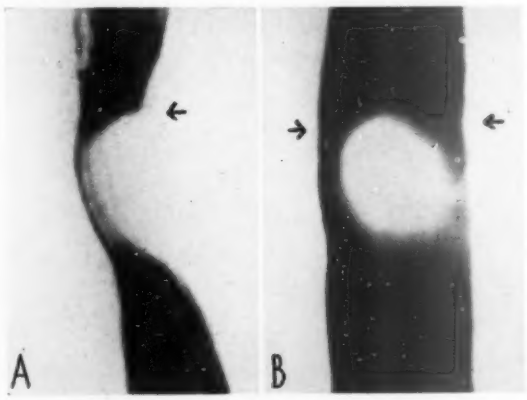

FIG. 14. Extrinsic tumor, attached only at the upper pole (arrow). (Piece of cork; its upper pole is sewed to the esophagus; postmortem study.) Note the sharp angle and sharp border at the upper attached edge (as found in intrinsic tumors), and the gentle slope and poorly defined border at the lower pole (as found in unattached extrinsic tumors).

ported above. The differentiation of these three types of lesions, however, instead of being based on a fundamental, roentgenological difference in appearance as studied in the experiments depends rather on the difference in the gross anatomical appearance of these lesions.

In separating intramural submucosal lesions from mucosal lesions the following features are helpful:

The surface of an intramucosal tumor is usually irregular, while that of an intramural extramucosal tumor is usually smooth. Mucosal lesions are ulcerated in most instances; extramucosal lesions are rarely ulcerated. These differences in the appearance of the surface of the lesions are usually easy to recognize, although pseudo-irregularity may be produced by the "smear effect" on the surface over an extramucosal lesion as described above.

Normal mucosal folds may be visible in the mucosal as well as in the extramucosal lesions; in both cases, they are the folds of the wall opposite to the tumor, and not the folds running across the lesion. Normal folds are more commonly visible in extramucosal than in mucosal lesions, due to the fact that in the relief picture the irregular surface of a mucosal tumor stands out and completely obscures the normal folds of the opposite wall.

Fig. 15. Ectopic pancreatic rest in the wall of the greater curvature of the gastric antrum below the mucosa (arrows). Note the similarity with the intramural lesions of the esophagus. (Operation.)

Fig. 16. Ulcerated leiomyoma of the gastric antrum. Sharply defined mass (arrows); surface smooth with exception of the small but deep ulceration (double arrow). (Operation.)

Extramucosal tumors are often demonstrable as large soft tissue masses outside the barium cast. Mucosal tumors are less apt to have such a visible soft tissue mass and this is particularly true when the surface of the mucosal tumor is smooth. In other words, while an infiltrating cancer may show an extrinsic tumor mass, its mucosal surface will be irregular. On the other hand, a mucosal tumor with a smooth surface is usually a polypoid growth which protrudes into the lumen and shows no soft tissue mass outside the normal circumference of the esophagus.

Regarding the differentiation of the intramural lesions and attached extrinsic lesions, the experimental studies have shown that an attached extrinsic lesion produces the same appearance as that of an intramural lesion. The experiments are, however, an exaggeration of the conditions in this type of lesion in a patient. In vivo, no tumor will be buried to such an extent in the outside of the esophagus as in some of the artificial tumors. Large tumors are usually attached to the esophagus over only a small part of their total circumference, differentiating them from intramural lesions. Aneurysms form an occasional exception to this rule. Small extrinsic lesions are rarely attached to the esophagus to such a degree although it is conceivable

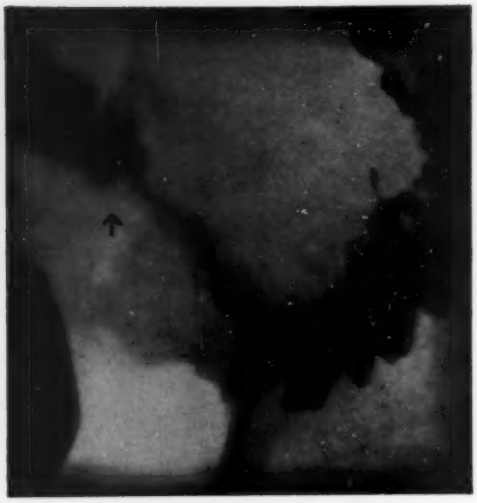

Fig. 17. Diverticulitis with marked fibrosis of the wall producing the appearance of an intramural extramucosal lesion. (Operation.)

that a tuberculous gland might be glued to the wall of the esophagus and simulate an intramural tumor.

The intraluminal protrusion of an intramural extramucosal tumor is usually larger than would be expected by an extrinsic tumor of similar size (Fig. 3). In general, the intramural extramucosal characteristics are easier to demonstrate in a small rather than in a large lesion.

If extrinsic tumors, e.g. a primary bronchogenic carcinoma or metastatic glands, involve the esophagus from the outside by infiltration, they become indistinguishable from an intramural lesion, because in such cases the lesions which are outlined by the barium are truely intramural.

We have become increasingly impressed by the roentgenological characteristics of the intramural extramucosal tumor and believe that, although at times the differentiation may be difficult or even impossible, a correct differentiation between mucosal, intramural submucosal and extrinsic lesions is possible in the majority of cases.

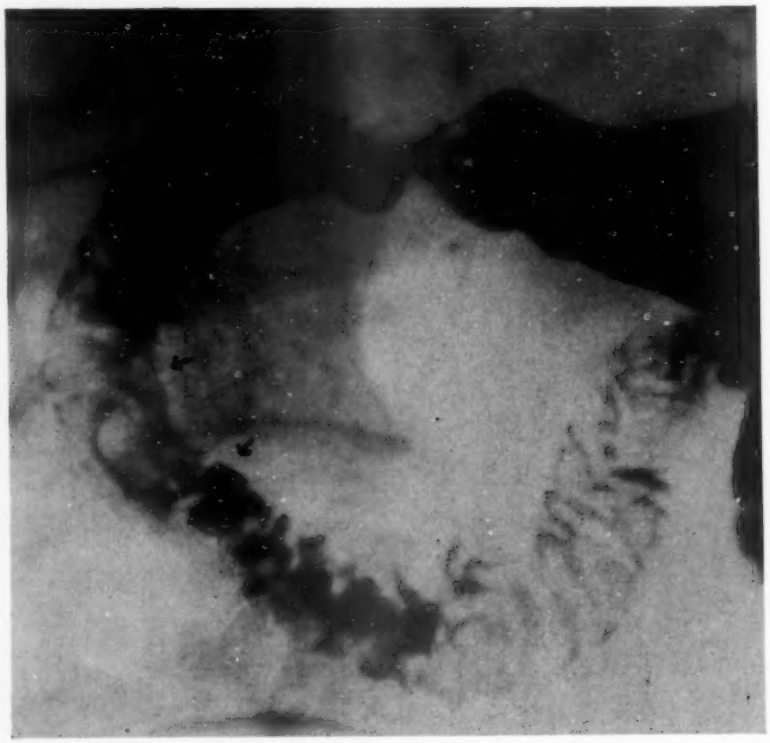

Fig. 18. Stone in the intraduodenal part of the common duct producing the appearance of an intramural extramucosal lesion. (Operation.)

INTRAMURAL EXTRAMUCOSAL LESIONS IN OTHER PARTS OF THE GASTROINTESTINAL TRACT

The characteristics of an intramural extramucosal tumor as discussed above are not confined to lesions of the esophagus. They are also present in similar lesions in other parts of the gastrointestinal tract.

Figure 15 shows the roentgenological appearance produced by a small localized ectopic pancreatic rest lying in the wall of the gastric antrum below the mucosa. The profile view is the same as seen in the intramural extramucosal lesions of the esophagus. Spindle cell tumors of the stomach (leiomyoma, leiomyosarcoma, neurofibroma, etc.) are other comparatively common representatives of intramural lesions (Sahler and Hampton[5]). In contradistinction to similar lesions of the esophagus, however, they show, not infrequently, a secondary localized destruction of the mucosa in the form of a rather small but deep ulceration (Fig. 16).

The recognition of the intramural submucosal lesions is important in the differential diagnosis of cancer and diverticulitis.[7] Due to marked, localized fibrosis in the wall, an intramural lesion may be produced by diverticulitis which differs from cancer only by the preservation of the mucosal surface (Fig. 17).

A particularly characteristic example of an intramural extramucosal lesion is the roentgenologic appearance of a stone in the intraduodenal portion of the common duct, just proximal to the ampulla of Vater (Fig. 18).

SUMMARY

Roentgenological findings in six intramural extramucosal lesions of the esophagus are reported (one neurofibroma, two cysts, histopathology not established in three cases).

Experimental studies are used in an attempt to establish the basic roentgenological characteristics of intramural extramucosal lesions, and to differentiate them from mucosal and from extrinsic lesions.

The knowledge of the roentgenological appearance of such intramural extramucosal lesions is of help in the diagnosis and differential diagnosis of lesions throughout the gastrointestinal tract.*

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* For discussion see page 37.

THE ROENTGEN DIAGNOSIS OF LESIONS INVOLVING THE ILEUM, CECUM AND PROXIMAL ASCENDING COLON*

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EARLY lesions involving the ileum, cecum and ascending colon are notorious for their obscure or lack of clinical symptoms and signs. In many instances, therefore, the detection of these lesions depends on the roentgen examination of the structures in the right lower quadrant of the abdomen. Furthermore, the roentgen studies in this region are prone to be difficult and confusing, and not infrequently one is faced with the question of "is there," or "is there not" a lesion present? Once demonstrated, the nature of the lesion is sometimes still more difficult to determine. The purpose of this paper is to present a few instances in which the clinical and the roentgen findings were equivocal and to present certain evidence which might, in the future, assist in the proper analysis of these problem cases.

For the roentgenologist, at the present time, there seems to be three methods of study. The barium meal, the opaque and double contrast enema and the study of suspected portions of the small intestine by the use of the Miller-Abbott tube. The individual methods have their advantages and disadvantages and it is often necessary to employ all three in order to obtain as much evidence as possible. There is no routine procedure which can be used in all patients but, except for those patients who show evidence of small intestinal obstruction, we are inclined to use the barium meal first and then the barium enema and in some instances the double contrast enema.

The water barium meal when properly carried out often produces valuable evidence. In our experience, its greatest value is in the detection of lesions of the small intestine or proximal colon by disturbances in the physiology and by alteration in the mucosal pattern. This meal should be followed through the small intestine by careful roentgenoscopic and frequent roentgenographic examination until the barium reaches the cecum. Particular attention should be paid to hyper- or hypomotility, to gas-filled loops, to abnormalities in peristaltic activity or segmentation contractions.

The barium enema may be given with or without previous catharsis as preparation. As a routine we prefer the use of castor oil catharsis and simple enemas as preliminary preparation to the opaque enema because, in most instances, the colon is found to be empty. Small defects in the cecum are sometimes most difficult to distinguish from undigested food particles or exaggerated mucosal folds. While it is true that spasm may result from catharsis or harsh enemas, we have accommodated ourselves to observing it and prefer repeated barium studies of a well cleaned colon to one where nonopaque contents are present. If the barium enema is given without previous cleansing of the colon, it should be expelled and the colon filled with barium again. The procedure should be repeated until the roentgenoscopist is satisfied that all portions of the colon are free of defects. We do not employ the double contrast enema as a routine procedure but only when we feel that additional information may be obtained.

If these studies seem insufficient, we then pass the Miller-Abbott tube until the bal-

* Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

loon becomes arrested or until, by roentgen evidence, the tip of the tube is in the region under suspicion. The balloon is then deflated and about 50 to 100 cc. of a thin barium suspension is injected through the tube during roentgenoscopic observation. Normally this barium will be seen entering the small intestinal lumen back of the tip of the tube and in most instances will pass on beyond the tip without hesitation. When a lesion is present just ahead of the tip of the tube, the barium may collect in a mass at the site of injection or regurgitate backward along the intestine. Hyperactive peristalsis and abnormal activity of the small intestine may be observed roentgenoscopically, and in some cases where there are mucosal lesions, palpation may aid in bringing out the defects in the mucosal pattern. In the presence of a colon lesion, *reflex spastic obstruction of the terminal ileum may occur which will produce a false stop of the small intestine tube*. In other instances, a sharp angulation and fixation of a loop of small intestine adjacent to a colon lesion may result in false stop of the intestinal tube.

A word of caution should be given concerning the interpretation of progression of the barium beyond the tip of the tube. The false appearance of progression of barium may actually occur in the presence of obstruction in those instances where considerable small intestine is telescoped over the Miller-Abbot tube. After the balloon is deflated the telescoped small bowel, which is normal, migrates beyond the tip of the tube and when one injects barium one gets the impression that no obstruction exists because the opaque material does not all regurgitate along the tube but some of it passes distal to its metal tip.

In our experience most early lesions in the ileum or cecum are evidenced by rapid small intestinal and rapid colonic motility. Why rapid motility should be obtained in one instance and delayed motility (in the absence of obstruction) in another is difficult to explain. Hypermotility of the small intestine may occur in early cancer of the cecum before metastasis has taken place. Certainly, one should consider the possibility of peritoneal irritation, alteration of the gradient of tonus, increased peristaltic activity and abnormal reflex stimuli as in the following cases.

Case I. S. E., white male, aged twenty-two, had a sudden onset of right lower abdominal pain and vomited. A diagnosis of acute appendicitis was made and the patient immediately operated upon. There was a cloudy fluid in the peritoneal cavity, the peritoneum was studded with small nodules. Biopsy from one of these showed the histopathological appearance of tuberculosis. The gastrointestinal examination made two weeks after operation showed very rapid small intestinal motility, a fine pattern and a hazy appearance of some of the barium filled loops. The cecum was somewhat deformed and its contour was irregular.

Case II. Mrs. H. A. C., white, aged forty-two, had diarrhea for many years. The gastrointestinal study showed a very rapid small intestinal motility. Some barium was seen in the cecum one-half hour after the meal. The lesion present in the ascending colon produced a smooth napkin-ring appearance. Distal to this lesion, the barium moved very rapidly through the colon. At operation a soft mass was found involving the ascending colon. There was no involvement of the peritoneum. The resected specimen showed a normal terminal ileum and cecum, a napkin-ring band of ulceration 9 cm. long encircled the ascending colon just above the ileocecal valve. On histological examination this was found to be tuberculosis of the colon.

Case III. W. K., male, aged fifty-six, admitted to the hospital with vague pains in the lower abdomen of one year's duration. Past history of a positive roentgen diagnosis of a lesion of the cecum. Laparotomy at that time showed adhesions around the cecum, but it was not opened. Following operation the condition recurred and a progressive anemia was noted. Physical examination was negative. The re-examination, by us, showed a rapid small intestinal and rapid colonic motility and a filling defect in the cecum. At operation the lesion in the cecum was found to be an adenocarcinoma.

Diarrhea may be due to rapid small in-

Fig. 1. Case iv. Terminal ileitis. The terminal ileum lesion does not show very well when distended by barium. Roentgenoscopically the abnormality was readily observed, however. The narrowing of the ileum in its terminal portion can be seen. At *a* it is slightly narrower than at *b*. The defect in the cecum, indicated by arrows, is not due to the pathological process in the cecum but to a band of adhesions around the cecum.

testinal motility, as in some cases of thyrotoxicosis. In other instances, diarrhea may be due to colonic hypermotility. The following case illustrates colonic hypermotility in association with a relatively early regional ileitis.

Case iv. D. S., white male, aged twenty-four, was admitted to the hospital with a mild diarrhea. He was having four or five loose watery stools each day. He also had some postprandial epigastric discomfort which he called "gas pains." On physical examination, the chest and abdomen were negative. There was a small ischiorectal abscess which was draining. The blood count was normal. The roentgen examination of the chest was also negative. Blood Wassermann and tuberculin tests were negative. The examination of the small intestine revealed a localized lesion about 3 inches in length involving the terminal ileum. There was constriction of the cecum at the level of the ileocecal valve. The cecal appearance time of the barium meal was within the limits of normal but the barium passed rapidly through the colon. The terminal ileum and cecum were

Fig. 2. Case iv. Terminal ileitis. The cecum, at operation, was seen to be entirely normal and the pathological process was confined to the ileum.

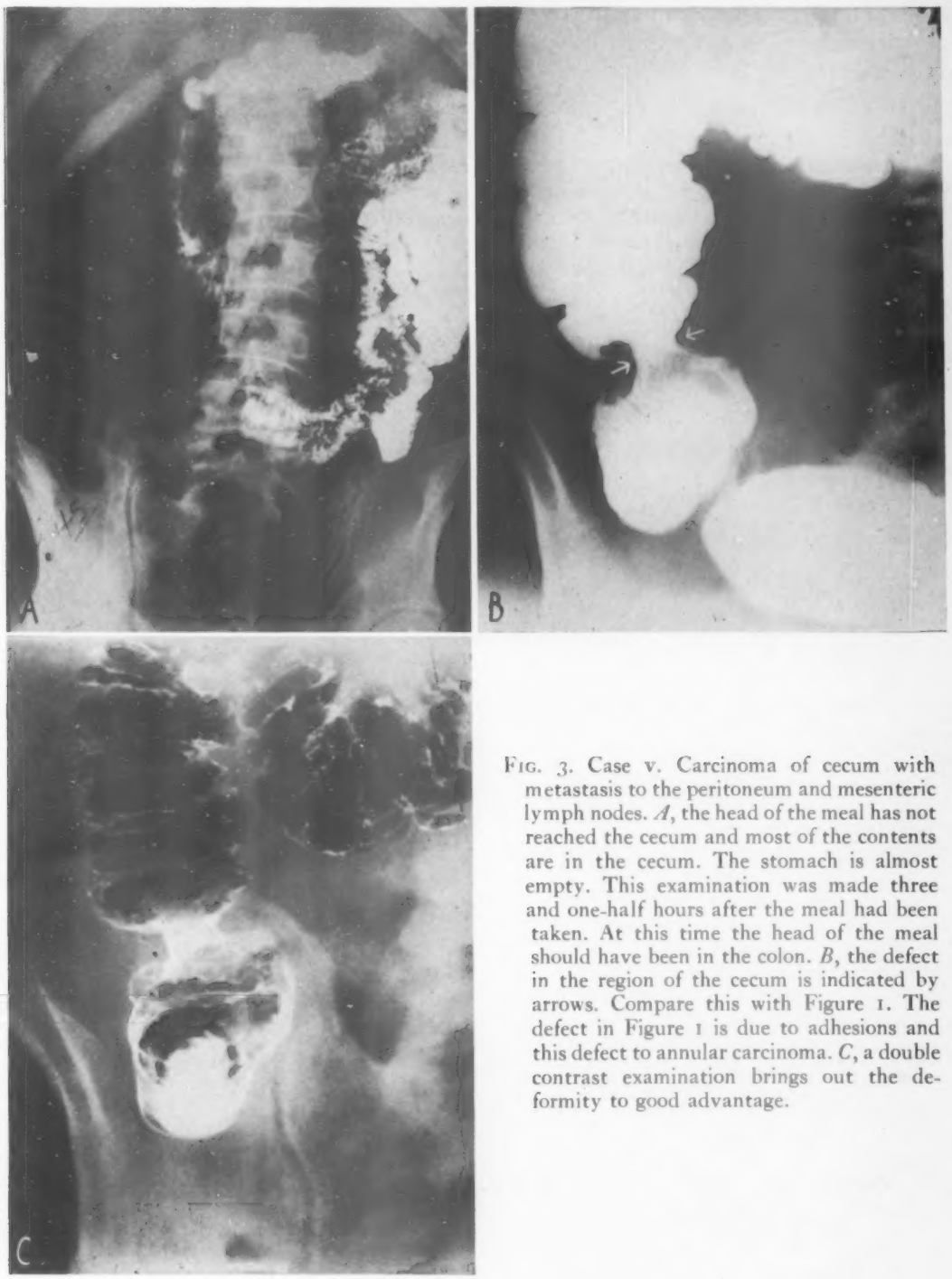

Fig. 3. Case v. Carcinoma of cecum with metastasis to the peritoneum and mesenteric lymph nodes. *A*, the head of the meal has not reached the cecum and most of the contents are in the cecum. The stomach is almost empty. This examination was made three and one-half hours after the meal had been taken. At this time the head of the meal should have been in the colon. *B*, the defect in the region of the cecum is indicated by arrows. Compare this with Figure 1. The defect in Figure 1 is due to adhesions and this defect to annular carcinoma. *C*, a double contrast examination brings out the deformity to good advantage.

resected wide of the lesion which proved to be a regional ileitis (Fig. 1 and 2).

Whatever the exact cause of the disturbance of small intestinal motility, its recognition is an important feature in the diagnosis of many lesions.

We have observed, frequently, a delayed small intestinal motility in patients who

have had metastatic malignancy in the abdomen. The following 2 cases are illustrative of such an observation:

CASE V. O. H., white male, aged fifty-four, was well until eight weeks before admission when an attack of sneezing brought on severe persistent pain in the lower back. Following this, he developed fever, malaise and anorexia. Physical examination of the chest and abdomen revealed no definite cause for the symptoms. The suggested clinical diagnosis was back pain on a skeletal-muscular basis. Four weeks after admission to the hospital, a barium enema showed a napkin-ring constriction of the ascending colon. At autopsy, this lesion was found to be a scirrhous carcinoma with involvement of the ascending colon and ileocecal area. There were metastases to the liver, lymph nodes and peritoneum (Fig. 3).

FIG. 4. Case VI. Myeloid infiltration of the cecum and terminal ileum in a patient with myelogenous leukemia. This lesion was thought to be carcinomatous by the roentgen examination and even at operation. Its true nature was not discovered until after microscopic examination. The deformity is present at the site of the arrows.

CASE VI. E. W. M., white male, aged seventy-two, was admitted because of severe weakness for three months. The blood count showed red blood cells 2,400,000; hemoglobin 44 per cent; white blood cells 2,700, with polymorphonuclears 41 per cent; lymphocytes 55 per cent, monocytes 4 per cent. Iron and liver therapy produced very little improvement and the patient was suspected of having aleukemic leukemia. A barium enema was done because of a positive benzidine test for blood in the stools. This showed the cecum to be constricted and displaced. In our opinion, this suggested the possibility of cancer of the cecum. At operation, a large mass was found which involved the cecum but not the surrounding tissues. The mass could not be resected so a transverse ileocolostomy was done. Four weeks later, at a second operation, the cecum and ascending colon were resected. At this time, the mass was smaller. Two months later, the patient was still very ill. The blood count indicated a myelogenous leukemia; white blood cells 56,550; polymorphonuclears 71 per cent; lymphocytes 6 per cent; myelocytes 21 per cent. The patient died at this time. The autopsy findings showed chronic myelogenous leukemia with myeloid infiltration of many structures (Fig. 4).

In the normal small intestinal study, it is not uncommon to observe a slow motility or an arrest of the barium column when the stomach is nearly empty and the head of the advancing column is in the ileum. In such instances, the ingestion of food or even the thought of food may cause the intestinal contents to pass on into the colon. This phenomenon, the gastro-ileocolic reflex, is well known to many roentgenologists. In a number of patients, we have observed clinical evidences of this reflex which has suggested to us some abnormality around the cecum and terminal ileum. These patients have complained of epigastric pain immediately upon eating, very much as one could expect in association with gastric ulcer. In fact, they are not infrequently diagnosed as ulcer or gastric neurosis.

In a few instances, we have observed delayed small intestinal motility in which the diagnosis of chronic appendicitis was tenable and was later somewhat substantiated by the clinical improvement of the patient after an appendectomy. We have been unable to differentiate, roentgenographically, the two conditions, chronic appendicitis and mesenteric variants or anomalies.

CASE VII. J. J., doctor, aged forty, had com-

plained of epigastric pains after eating since the age of five years. He had always had a good appetite but his ability to enjoy food was limited because of epigastric pain and vomiting which occurred frequently after eating a full meal. At times, he was able to relieve his abdominal symptoms by massage of the right lower abdomen. Barium enema showed a normal colon, the ileum was visualized and was not freely movable. At one point, it was bound down to the lateral pelvic wall by a very short mesenteric band. This band was released, the appendix, which showed no signs of inflammation, was removed and the patient has had an excellent recovery (Fig. 5).

A closely allied condition, although one of different etiology, is that concerned with adhesions in the right lower abdomen. McCann[4] has described the condition which he calls the "omental adhesions syndrome." The patients give a history of one or more abdominal operations and have delayed small intestinal motility. They complain chronically and persistently of postprandial distress, nausea, regurgitation, vomiting and constipation. Pain in the right lower abdomen is often severe and may be relieved by flexing the thighs.

Case viii. L. B., white female, aged fifty-three, had a previous hysterectomy and bilateral salpingo-oophorectomy, an appendectomy and a cholecystectomy. She complained of pain in the right lower abdomen which was aggravated by walking and relieved by flexing the thighs on the abdomen. On physical examination, there were no masses palpable but the patient was quite tender over the cecum. The small intestinal study showed a delay in the motility. The cecum was somewhat conical but could be made round in contour by overdistention with barium. The terminal ileum showed a lack of normal motility to palpation and there was considerable tenderness over this area. Operation revealed the omentum rolled up and adherent to the anterior abdominal wall, in the right lower quadrant. Many adhesions were present involving the ileum and cecum but there was no other demonstrable lesion. The ileum appeared to be in spasm. These findings were compatible with the omental adhesions syndrome.

The use of the Miller-Abbott tube in determining the nature and site of lesions in the small intestine is highly advantageous. One can often obtain much valuable information by injecting barium directly at the site of the lesion.

Case ix. F. DeV., young male, had several previous operations for regional ileitis. At one operation, an ileocolostomy was done. The patient was admitted to the hospital with

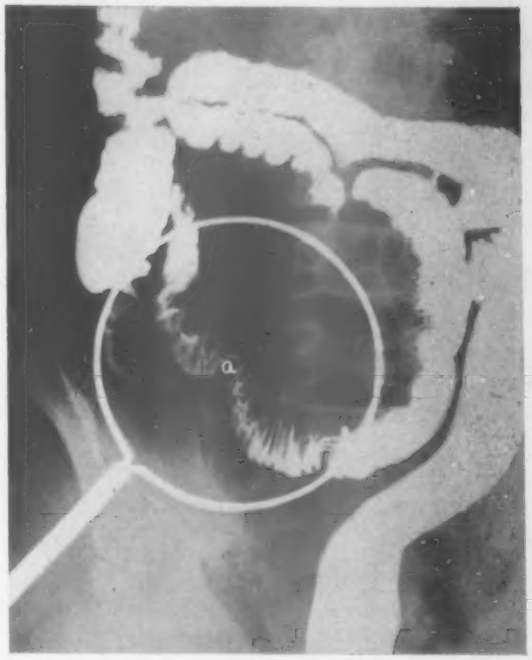

Fig. 5. Case vii. Lane's band involving the terminal ileum and appendix. The kinking of the ileum at *a* could not be straightened out by manipulation.

evidence of intestinal obstruction. Following decompression with the small intestinal tube, a small amount of barium was injected through the tube. This showed the area of recurrence of the ileitis in the small intestine adjacent to the site of the ileocolostomy. These findings were confirmed by operation and resection of the involved area.

Occasionally when using the Miller-Abbott tube a false impression of obstruction is obtained. In non-obstructive ileus from any cause one may observe a collection of barium proximal to the tip of the tube at the site of its entrance into the lumen of the gut. If the patient is rotated, however, this "puddle" may be seen to pass beyond the

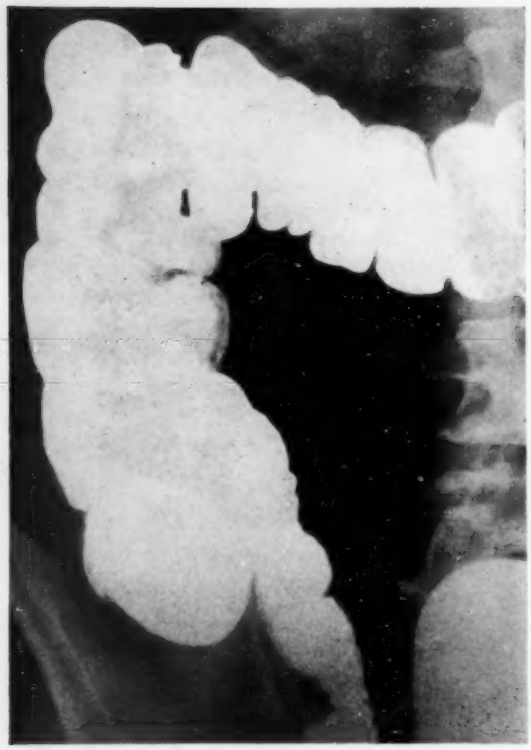

Fig. 6. Case xi. Colon negative. The illustration is used to show the rounded appearance of the cecum that is usually seen. Note that there is barium in the terminal ileum. The rounded appearance of the normal cecum should be differentiated from that produced by a malignant process. See Figure 7.

end of the tube. Particular care is necessary in the interpretation of obstruction, when using the small intestinal tube, when there is a colon lesion present. Under such circumstances, spastic obstruction in an area adjacent to the lesion of the colon may produce a false arrest of the tube. In other instances, a sharp angulation and fixation of a small intestinal loop adjacent to the colon lesion may stop the balloon and tube.

Case x. A. M., white male, aged seventy-five, was admitted with pain in the lower abdomen, vomiting and abdominal distention. He had no previous operations. Physical examination of the abdomen revealed no masses or hernia. The barium enema showed multiple diverticula throughout the distal colon. The cecum was deformed and could not be definitely identified. There was evidence of small intestinal obstruction. The Miller-Abbott tube was passed and the small intestinal distention was relieved. The barium regurgitated proximally but none passed into the cecum. At operation, there was a raw red friable surface over the cecum which was thought to be inflammatory rather than malignant. There was no evidence of a lesion of the ileum but this structure was bound rather firmly to the lateral pelvic wall. The lesion could not be resected and ileocolostomy was done. The patient died of heart disease one week later. At autopsy there was evidence of a small perforation of a diverticulum of the cecum.

Case xi. P. M., a white woman, aged sixty-eight, was admitted with generalized crampy abdominal pains not related to food. There was no change in bowel habit. No weight loss, no jaundice and no blood in stools. The physical examination of the abdomen was negative. Benzidine test positive for occult blood. Barium enema shows a smooth colon, rounded off proximal colon with no barium in the terminal ileum. There is a gas collection adjacent to the colon. In evaluation film, no additional information obtained. Miller-Abbott tube was arrested in the terminal ileum and barium regurgitated along tube. Roentgen diagnosis, obstruction of ileum. Operative diagnosis, carcinoma of cecum (Fig. 6 and 7).

There are three lessons to be learned from the studies in this case. First, enough significance was not attributed to the gas collection; second, the rounded shadow of the colon should not be dismissed as normal and unless one can identify the appendix or terminal ileum one cannot be sure that the cecum has been filled, and third, the false stoppage of the Miller-Abbott tube occurs in some of the cecal and ascending colon lesions as a result of reflex ileal spasm.

Abscesses in the right lower abdomen do not always present the same roentgenological appearance. A localized abscess arising from a retroperitoneal appendix may be suspected in certain patients who present extrinsic colonic pressure defect.

Case xii. B. G., white female, aged forty-one, had an acute stabbing abdominal pain and vomiting one month before admission. This lasted during one night and gradually subsided leaving a dull pain in the right abdomen which

had persisted up to the time of admission. On admission, she was not acutely ill but she complained of weakness, loss of appetite and occasional vomiting. On physical examination, there was a mass in the right lower abdomen about the size of a grapefruit. Peristalsis was normal; white blood cells 7,400; hemoglobin 75 per cent. The barium enema showed displacement of the cecum and ascending colon anteriorly and toward the midline. The appendix was not identified. At operation, the peritoneal wall and the cecum was drained of several ounces of pus. This, apparently, arose from a retrocecal appendix.

In the following patient the correlation of clinical and roentgenological findings led to the proper diagnosis. From the roentgenologic appearance alone, however, one must also consider the possibility of retroperitoneal sarcoma or lymphoblastoma. The roentgen findings will often clarify a confusing clinical picture and in some instances may explain operative findings, as in the following patient:

Case xiii. G. S., Jr., white male, aged fifteen, was admitted to the infirmary of a New England private school for treatment of an upper respiratory infection. Six days after admission to the infirmary, he developed pain, tenderness and rigidity in the abdomen. The leukocyte count was 15,000 with 94 per cent polymorphonuclear cells. He was operated upon through a McBurney incision. The appendix could not be located. There was a small amount of free fluid in the peritoneal cavity and an elastic mass could be felt on the lateral side of the cecum in a retroperitoneal position. Several enlarged lymph nodes were found along the right colic vessels. The surgeon's impression was a retroperitoneal lesion, probably due to lymphosarcoma. One month later, he came under our observation. At this time, he had clinical evidence of an embolic lesion in the base of the right lung and had a small amount of bloody sputum over a period of several days. A palpable mass was present in the right lower abdo-

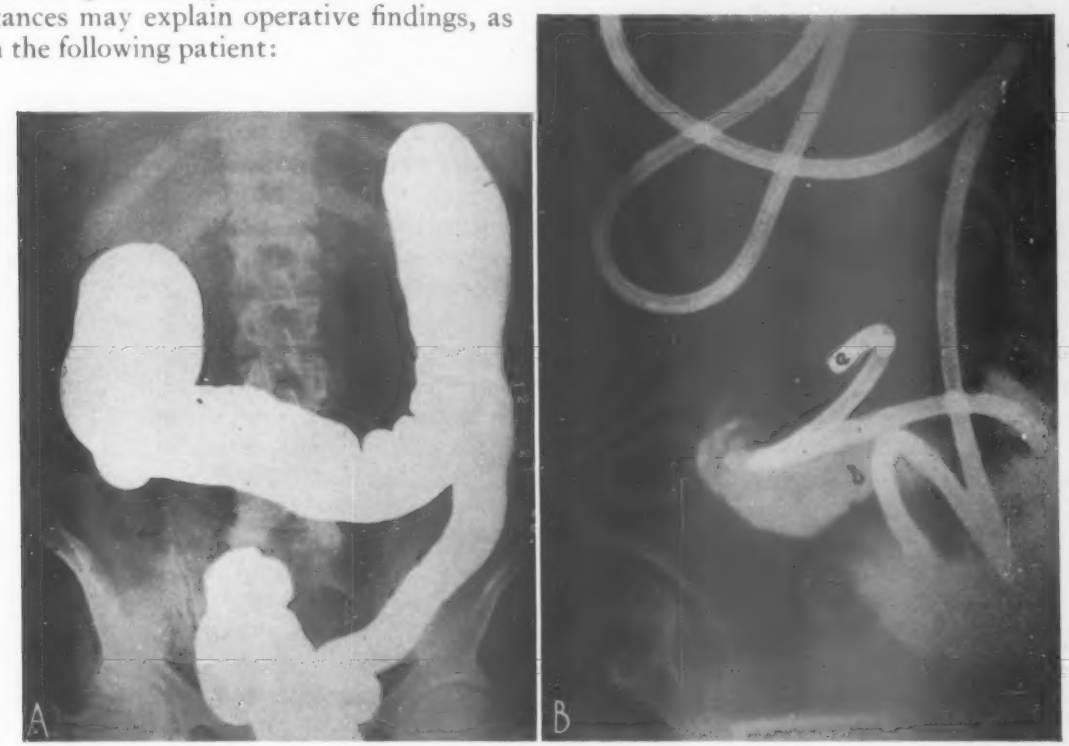

Fig. 7. Case xi. Carcinoma of the cecum. *A*, note the rounded appearance of the opaque column in the ascending colon. The rounded appearance in the ascending colon simulates that seen in Figure 6. There is a small collection of gas in the cecum but no opaque contents entered that portion of the colon. *B*, the metal tip of the Miller-Abbott tube is seen at *a*. The barium has regurgitated along the tip at *b*. This is a false stop of the tube presumably due to a spasm of the ileum in a patient who has carcinoma of the cecum.

men and the patient also had palpable lymph nodes in the anterior and posterior cervical region. The roentgen examination of the abdomen at this time showed a single pea-sized calcification of mottled density situated just above the right ileal crest. A barium enema showed considerable deformity and displacement of the cecum and ileum. The calcification was retrocecal and somewhat lateral to the cecum. On opening the abdomen, the omentum was adherent to the previous scar, the terminal ileum was adherent to the mass along its vesicle aspect. Dissection finally separated the structures and exposed an enormously distended and greatly thickened appendix. The tip of the appendix was retroperitoneal and contained a single large concretion. This evidently acted as a foreign body and prevented complete resolution of the inflammatory process.

DISCUSSION

In the differential diagnosis of lesions involving the terminal ileum and cecum, one must consider many possibilities among which are the benign and malignant tumors; tuberculosis and other less common granulomas such as tularemia, syphilis, etc.; nonspecific granulomas; a group of inflammatory processes including diverticulitis, pyogenic ulcers, amebic ulcers and ulcerative colitis; appendiceal abscess and congenital or acquired adhesions and bands.

Tumors. The benign tumors which occur in this region are rare. They include adenoma, myoma, fibroma, lipoma, hemangioma, teratoma, cyst and argentaffinoma. Such tumors are prone to extend into the lumen of the gut and produce a varying sized defect either in the barium column or in the gas-filled portion of the intestinal tract. Such a defect is usually round and smooth. When pedunculated, these tumors tend to produce intussusception. Ashbury[1] states that one-fifth of the cases of intussusception with tumor are caused by benign tumors and one-seventh by malignant growths. The benign tumors seem to be more frequent in the small intestine and the malignant ones in the large intestine. The roentgen appearance of an inverted U in the colon is characteristic of intussusception and in a few favorable cases the tumor defect may be seen protruding into the lumen at the apex of the intussusception. In certain instances of intussusception, the barium meal examination produces a large filling defect, in the central portion of which one can see a thin line of barium, the central canal of the invaginated loop. Rarely, a pedunculated tumor may break off from its attachment and be passed by bowel. When benign tumors are extraluminal, they may not produce any demonstrable roentgen evidence until they become quite large. Then they may produce a pressure defect in the barium-filled gut. These defects frequently cannot be differentiated from cysts, localized abscess or cancer. Carcinoid tumors or argentaffine tumors are benign or malignant. They occur most frequently in the appendix or ileum. The presence of multiple tumors in the ileum is suggestive of carcinoid growths.

Carcinoma of the cecum or ascending colon is the most common malignant tumor to be found in the right lower quadrant. Medullary tumors may produce intraluminal defects of polypoid nature, whereas scirrhous carcinoma may produce a smooth constriction of the wall of the bowel. The intraluminal defects are usually more easily detected than the early scirrhous lesions which may appear as a haustral marking or the very late smooth constrictions which completely occlude the ascending colon. A double contrast enema study with spot films of suspected areas is advisable and frequently helpful when dealing with intraluminal defects in the colon and terminal ileum. Infiltration and rigidity of the wall may be demonstrable by roentgenoscopy. Cancer of the terminal ileum is a rare condition which must be differentiated from some inflammatory conditions. Malignant tumors of the small bowel are usually stenosing and obstructive. The mucosal pattern is abnormal and palpation during roentgenoscopy may show a certain amount of fixation. Other malignant tumors of the small bowel may grow outward away from the lumen. In these cases, a large mass is

present, the bowel is moderately dilated throughout the area of the lesion and there is no obstruction. The normal mucosal pattern is absent.

Tuberculosis of the ileum and proximal colon is most commonly secondary to active pulmonary disease, although a few cases have been reported in which the disease is primary in the intestinal tract. This is more likely to be the case in children than in adults. Broadly speaking, most of the roentgen evidence of the hyperplastic and the ulcerative forms of the disease is seen in the ileum and cecum since this is the region which is most extensively involved by the pathological process. Roentgen evidence of irritability is an important sign of ileocecal tuberculosis. The presence of the opaque progress meal in the ileum and in the transverse colon with only a few specks of barium in the terminal ileum and cecum has been described by Stierlin.[5] Small intestinal motility is frequently increased or decreased. Colon motility is frequently increased. Locally, by roentgenoscopy and roentgenography, one may observe filling defects due to ulceration, tumor or adhesions. Some fixation is often present and the lumen of the bowel is narrowed. A contrast enema may show multiple ulcer craters or hyperplastic mucosal defects. Not infrequently, the ileocecal valve prevents regurgitation of the enema into the ileum, although where mural infiltration has occurred the ileocecal opening may be gaping and incompetent. The tumor mass may produce a high displacement of the cecum and ileum and barium may, in some instances, be seen to enter intra-abdominal sinus tracts or fistulae.

Regional ileitis or nonspecific granuloma is observed in young adults. It is more frequent in the male than the female (Crohn, *et al.*[2]). The chest roentgenogram fails to show an active tuberculous lesion. The disease is often localized to the terminal ileum and stops abruptly at the ileocecal valve. However, some cases involve other segments of the bowel, chiefly the jejunum, ileum and colon. A palpable mass is not present early in the course of the disease. The early roentgen changes are a delayed or an increased small intestinal motility with obliteration of the normal mucosal pattern. Irritability may be present but may not be as severe as with some other lesions in this region. Later in the course of the disease delayed motility with a narrowed, rigid lumen and the string sign[3] may be present. Skip areas of normal appearing gut may occur either in the small intestine or in the colon.

Diverticulitis of the right colon is unusual. These patients may be operated on under the clinical impression of acute appendicitis or cholecystitis. Roentgen findings are not very reliable except to demonstrate the presence of diverticula elsewhere in the colon and irritability in the cecum or ascending colon. Diverticula of the ileum are quite rare except where a generalized diverticulosis of the intestine is present.

Roentgen findings in idiopathic ulcerative colitis are usually quite characteristic. The appearance varies depending upon the stage of the disease. The cecum and ileum are not usually involved until late in the disease. A segmental involvement may occur in which normal appearing areas separate areas of smooth constriction. Hyperplastic mucosal patterns with polypoid appearance can be easily detected by contrast enema study.

The earliest roentgen evidence of amebic colitis may be irritability and spasm of the cecum. The ileum is not involved and the process may extend diffusely around through the colon. The cecum is cone or pouch shaped and the ileocecal valve often incompetent. These changes usually suggest an amebic infection but the exact diagnosis cannot be made solely by roentgen methods.

Chronic or subacute appendiceal abscesses produce a deformity and displacement of the cecum and to a lesser extent of the ileum. This deformity may be smooth in outline and resemble an extrinsic tumor. The mucosal pattern is not abnormal. The appendix is not visualized although it may

contain one or more radiopaque fecaliths. When the abscess is retrocecal the appearance is rather characteristic of a localized abscess although a retroperitoneal sarcoma or other tumor must be considered.

Very large lesions of the bowel with irregularity of contour, constriction of the lumen and obliteration of mucosal pattern are seen with unlocalized abscesses. Such a lesion may be produced by a perforation of the bowel. The antecedent cause of the perforation is frequently obscured by the deformity of the abscess.

Adhesions about the cecum are difficult to detect by roentgen methods. In many cases, however, presumptive evidence of such may be obtained by the observation of a smooth, somewhat conical shaped cecum which may be made to expand. The ileum may be kinked and fixed to the mesial aspect of the cecum and palpation will be unsuccessful in separating the two.

In general, the clinical findings and the patient's history are most important in evaluating the roentgen observations in any lesion of the ileum or cecum and it is only through a careful collection and correlation of all the data that the proper diagnosis is approached. Although it may be impossible to determine the nature of the lesion from the roentgen findings in many instances, the knowledge of the site, extent and anatomical relations of the lesion are of considerable value to the surgeon and to the patient.*

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* For discussion see page 37.

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LYMPHOBLASTOMA PRIMARY IN THE GASTRO-INTESTINAL TRACT*

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USED in a broad sense to denote any pathologic process, neoplastic or non-neoplastic, with which the idea of tumor is in any way associated, the term "tumefactive lesion" is a useful one in roentgenologic diagnosis, just as it is in gross pathologic diagnosis. The term conveys certain definite notions about the gross morphologic features of the lesions to which it is applicable, but it bears no etiologic or histologic connotations. It is used, therefore, when the diagnostic elements necessary for the development of a more refined diagnosis are either not available or not sufficiently distinctive. We stand among those who are convinced that roentgenologic examination can be made to establish the presence of any tumefactive lesion in the gastrointestinal tract at least as early in the anatomic development of that lesion as it is able to cause symptoms and be manifested by clinical signs. We also have maintained that roentgenologic criteria are at hand by means of which it is possible to distinguish neoplastic lesions dependably from those that are non-neoplastic, and that this differentiation can be made in all instances in which it is possible to recognize the neoplastic or non-neoplastic nature of the lesion at gross pathologic examination. At this point, however, we adopt a more conservative attitude. When the roentgenologic examination has demonstrated that a tumefactive lesion is present and has made available the criteria for the distinction between neoplastic and non-neoplastic tumefaction, we consider it to have made about as great a contribution to the final diagnosis as may logically be expected of it. Fundamentally reliable roentgenologic signs by which the various etiologic types of non-neoplastic tumor can be distinguished from one another have not been described, nor have we been able to find, in the literature available to us, a well-founded set of criteria for distinguishing the various histologic types of gastrointestinal neoplastic lesions from one another. Even the roentgenologic diagnosis of malignancy versus benignancy is considered to be on an insecure footing, for while there are diacritical roentgenologic signs which denote that a given neoplastic lesion is malignant, there are no such signs of benignancy once the diagnosis of neoplasm is established.

We carried no high hopes, therefore, about a fruitful result when we decided to review certain cases of lymphoblastoma of the gastrointestinal tract seen at the Mayo Clinic with the twofold object (1) of elaborating from our experience a roentgenologic differential diagnosis between this type of neoplasm and other types occurring in the gastrointestinal tract, and (2) of testing the validity of the roentgenologic diagnostic criteria put forth by others who had conducted similar studies. It was immediately apparent that we were going to try not only to distinguish between the two great groups of malignant lesions of the gastrointestinal tract, the carcinomas and the sarcomas, but to distinguish the various histologic types of the much more rarely encountered of the two groups, the sarcomas. We knew of a few occasions when a presumptive diagnosis of lymphoblastoma of the stomach or large intestine had been attempted by some of us, but the instances in which that diagnosis was substantiated in the course of subsequent events were so

* Presented at the Forty-second Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 23–26, 1941.

few that we assumed that our diagnosis should probably be considered as little better than a fortunate guess.

By this time the literature on lymphoblastoma of the gastrointestinal tract has reached almost voluminous proportions. It consists chiefly of reports of 1 to 3 or 4 cases and in relatively few of these is emphasis placed on roentgenologic diagnosis. Holmes, Dresser and Camp[1] reviewed the roentgenologic findings in 8 cases of lymphoblastoma of the stomach. In only 1 of these was the diagnosis of lymphoblastoma offered; roentgenologic examination revealed a filling defect in the lower third of the stomach with ulceration. Peristalsis was absent from the region involved. The patient was known, however, to be suffering from lymphoblastoma of the peripheral lymph nodes, and so it was suggested that the changes in the stomach might be due to this disease. After roentgen therapy the gastric tumor diminished in extent and peristaltic waves passed over the involved region without interruption. In 2 cases no evidence of a gastric lesion was discovered at roentgenologic examination. In 5 cases the findings were those of carcinoma of the stomach, but the authors noted that in some of these peristalsis was not interfered with to the extent generally observed when carcinoma is the cause of the roentgenologic changes.

Ruggles and Stone[2] studied the roentgenologic findings in 11 cases of lymphoblastoma of the stomach. They concluded "that there is no type of lesion or region of involvement characteristic of lymphoblastoma, and therefore no characteristic roentgen finding," but "when gastric peristalsis persists with a lesion of the stomach it is most likely to be a lymphoblastoma." Martin,[3] by means of an exhaustive study of the literature on the subject of lymphoblastoma primarily or secondarily involving the gastrointestinal tract, combined with a review of the roentgenologic findings in 19 cases of gastrointestinal lymphoblastoma observed at the Massachusetts General Hospital, undertook to develop a foundation in pathologic anatomy for the roentgenologic diagnosis. He mentioned "thickening and distortion of the rugae, displacement and pressure defects of the fundus, a double lesion of the gastro-intestinal tract, a lesion of the pylorus that extends over the valve and involves the duodenum, and changes in the duodenal loop associated with pressure defects on the fundus of the stomach and splenic flexure (enlargement of the head of the pancreas associated with an enlarged spleen)" as anatomic characteristics of lymphoblastomatous lesions. On the basis of these findings, Martin claimed that a definite diagnosis of gastric lymphoblastoma was made in 5 cases in which the diagnosis was subsequently confirmed, and in 4 other proved cases lymphoblastoma was mentioned as a possibility. Yet in not a single one of his published abstracts of case histories was the term "lymphoblastoma" or any other allied term mentioned in the roentgenologic diagnosis, although some of the descriptions of the roentgenologic findings did conform, in a general way, to the anatomic changes he outlined as being features of the disease. Archer and Cooper[4] had opportunity to study 3 cases of primary lymphosarcoma of the stomach. They came to the conclusion that "no single symptom or roentgen sign is pathognomonic," and that enlarged rugae do not play a prominent part in roentgen diagnosis. We could find no author, except Martin, who could be convinced that an independent roentgenologic diagnosis of lymphoblastoma of the stomach, or for that matter of the large or small intestine, is possible.

Reported cases of this type of lesion in the intestinal tract proper are very few, and we could not find any instance in the literature available to us in which the roentgenologic findings were distinctive. Holmes[5] reported a case in which the duodenum appeared to be stiff and thickened, and at operation it was shown that a long segment of jejunum was involved in the lymphoblastomatous process. Swan[6] reported a case of lymphoblastoma of the cecum which

was manifested roentgenologically as cecocolic intussusception. Pattison[7] reported an instance in which a short constricting malignant lymphoma produced an ileocolic intussusception and was revealed as such at roentgenologic examination, and in another case an ulcerohyperplastic lesion of the ileum and cecum, grossly simulating a tuberculous process, was revealed roentgenologically by "spasticity and irregularity" of the ascending colon. In Golden's[8] case of diffuse infiltrative lymphosarcoma of the duodenum and jejunum, the disease produced the typical roentgenologic syndrome of a deficiency state in the small intestine. Present[9] reported 2 cases of primary lymphosarcoma of the duodenum in both of which the roentgenologic manifestations were similar to those ordinarily seen in cases of hyperplastic enteritis. In 1 of Chont's[10] recently reported cases there was a filling defect in the upper part of the jejunum near the ligament of Treitz which had all of the roentgenologic characteristics of a neoplastic lesion, and Chont considered the lesion to be a lymphoblastoma before operation was performed.

A comprehensive review of other reports of cases of lymphoblastoma of the gastrointestinal tract revealed that this type of neoplastic lesion is manifested roentgenologically in various ways. In the stomach the roentgenologic manifestations of lymphoblastoma reported consisted of (1) filling defects which were not distinguished from those produced by carcinoma, (2) gastric ulcers morphologically resembling the simple peptic ulcers of the stomach, (3) obstructing lesions at or below the pyloric third of the stomach, and (4) more or less diffuse infiltrative processes with thickening of the submucosal structures, sometimes with, sometimes without, marked prominence and distortion of the gastric rugae, so that the roentgenologic changes suggested at times the linitis plastica type of carcinoma of the stomach, at other times a form of diffuse hypertrophic gastritis. In the small intestine the roentgenologic changes consisted of (1) filling defects or other types of deformities, such as carcinomas ordinarily produce, (2) diffuse thickening and contracting deformities resembling the changes frequently seen in hyperplastic enteritis, (3) obstruction of the small intestine, (4) entero-enteral or enterocolic intussusception and (5) the changes ordinarily associated with the deficiency states. In the large intestine lymphoblastoma was manifested roentgenologically by (1) filling defects not unlike those produced by carcinoma and other histologic types of sarcoma, (2) colocolic intussusceptions and (3) large sessile polypoid lesions.

OBSERVATIONS IN CASES STUDIED

For this study we selected the cases which had been entered in the statistical files of the Mayo Clinic under the designations "lymphoblastoma," "lymphosarcoma," and "Hodgkin's disease" of the esophagus, stomach, small intestine, and colon, from January 1, 1930 to April 1, 1941. By a careful study of these records those in which it was not firmly established that the lymphoblastomatous lesion was primary in the intestinal tract were eliminated. Thus no case of lymphoblastomatous involvement of the peripheral lymph nodes or of other manifestations of generalized lymphoblastoma was included. There seemed to be no advantage either, from our point of view, to review those cases in which adequate roentgenologic examination, for one reason or another, was not performed on that part of the gastrointestinal tract which at surgical exploration or necropsy proved involved with the lesion under investigation. When these eliminations had been made, the series consisted of 25 cases in which the stomach was involved, 3 in which the small intestine was involved, and 6 in which the lesion was in the large intestine. No instance of esophageal lymphoblastoma was encountered.

Lymphoblastoma of the Stomach. In no instance was the diagnosis of lymphoblastoma rendered from the roentgenologic findings nor from the clinical and roent-

FIG. 1. *Left.* Extensive deformity of the lower two-thirds of the stomach; this was interpreted as a removable carcinoma; *right*, the lesion which was removed at operation; pathologic diagnosis: lymphosarcoma.

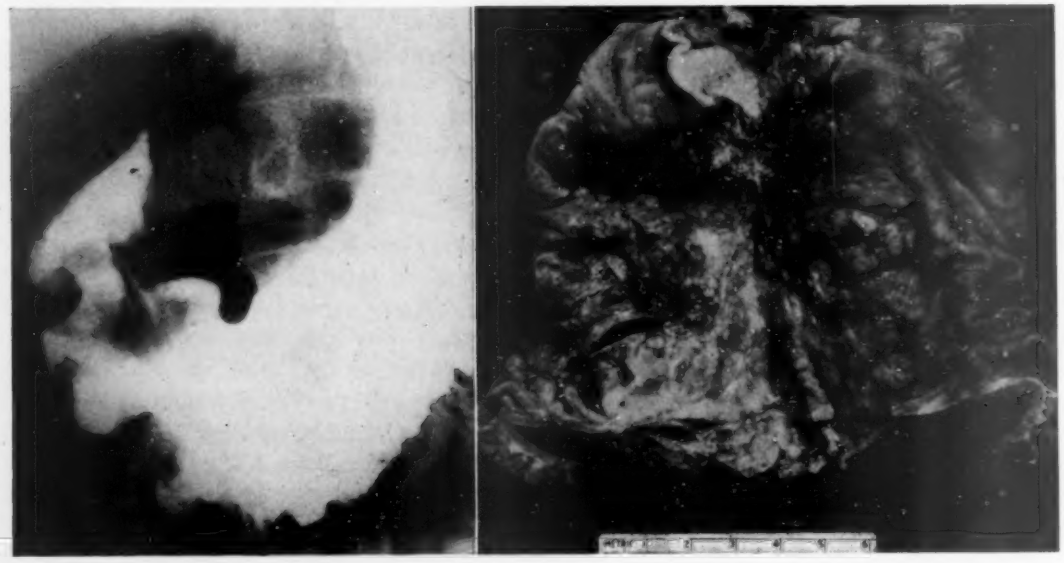

FIG. 2. *Left.* A deformity of the pyloric end of the stomach; the patient was a man twenty-nine years old; the roentgenologic diagnosis was "resectable carcinoma of the pyloric end of the stomach"; *right*, the resected lesion; pathologic diagnosis: lymphosarcoma.

genologic findings considered together. In 19 of the 25 cases an unqualified roentgenologic diagnosis of carcinoma was offered, and in each of these instances the final preoperative clinical diagnosis was also carcinoma of the stomach (Fig. 1 and 2). In 1 instance a polypoid lesion was described on the posterior wall of the stomach in its middle third. This proved at operation to be a large lymphosarcoma firmly attached to the pancreas and could not be excised. The patient received roentgen therapy, but died within a year. In none of these cases was gastroscopic examination performed. In 3 cases ulcerating lesions were described. Malignancy was suspected in each instance. Two of these ulcers were situated near the lesser curvature near the angle of the stomach (Fig. 3 left), the third was near the greater curvature on the posterior wall, and was suspected of being a secondary type of gastric ulceration caused by a mural tumor of the stomach or by a lesion extrinsic to the stomach but in contact with it (Fig. 3 right). In 1 instance in which the roentgenologic findings did not indicate any abnormality a "large tumor in the fundus" was found at gastroscopic examination, but the lesion proved to be amenable to partial gastrectomy!

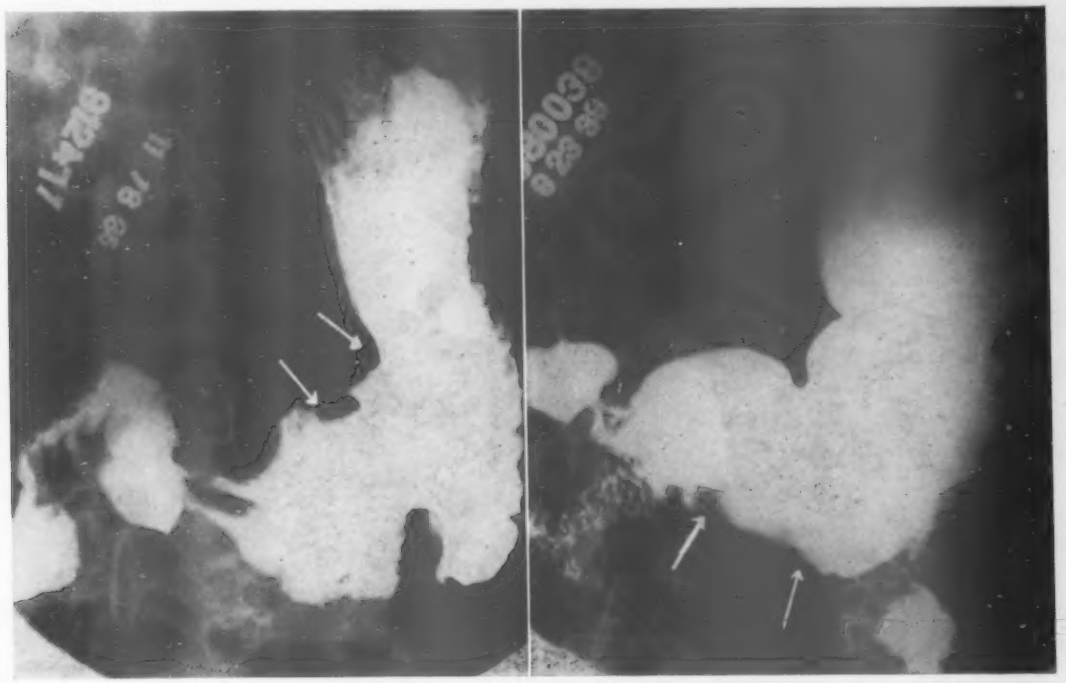

Fig. 3. *Left.* Arrows indicate an irregular ulcerating lesion of the lesser curvature at the level of the angle of the stomach. The patient was a man forty-nine years old. The roentgenologic diagnosis was "resectable ulcerating carcinoma." The lesion was removed surgically in November, 1935, and was shown to be a lymphosarcoma at pathologic examination. The patient was alive and well in May, 1941. He received no roentgen therapy.

Right. The roentgenologic diagnosis was "irregular ulcerating lesion lower one-third of the stomach near the greater curvature." The patient was a woman forty-six years old. The lesion was removed in October, 1939, and proved on pathologic examination to be a "malignant lymphoblastomatous ulcer." The patient was alive and well in June, 1941. She received fractional roentgen therapy elsewhere.

Review of the roentgenograms and of the notes made at the roentgenoscopic examinations gave no tangible clues as to how a closer approximation could be made to the

final diagnosis. We had several opportunities to re-examine the patients whose lesions could not be removed surgically and who were subjected to roentgen therapy. Even then we failed to be impressed with any features that could be used to distinguish lymphoblastomas from other types of malignant lesions, except that the lymphoblastomas made more favorable responses to radiation therapy.

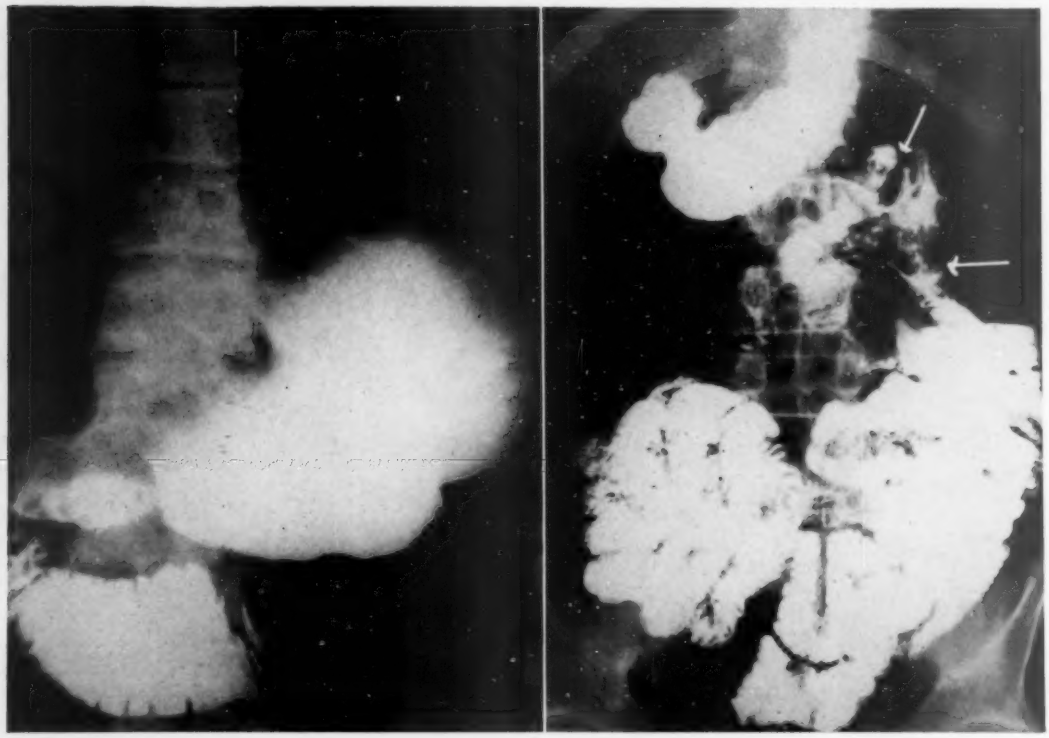

Fig. 4. *Left.* The stomach and a portion of duodenum considerably dilated above an obstructing lesion. The roentgenologic diagnosis was obstruction of lower part of duodenum. The patient was a man sixty-five years old. At operation the lesion proved to be inoperable on account of its size and of its intimate attachment to the pancreas. The patient died four days after operation of pneumonia. At necropsy the lesion proved to be a lymphosarcoma of the upper part of the jejunum.

Right. The stomach and upper portion of the small intestine. The arrows indicate the site of the lesion which proved to be a lymphosarcoma.

Lymphoblastoma of the Small Intestine. Only 3 cases in which lymphoblastoma was primary in the small intestine were observed since 1930 in the Section on Roentgenology in the Mayo Clinic, 1 of them very recently. In the first of these the lesion was revealed simply by obstruction in the mid-duodenum, with considerable dilatation of the duodenal segments above this obstructing process (Fig. 4 left). The lesion could not be removed surgically and the patient died a few days after operation of bronchopneumonia. Necropsy revealed primary lymphosarcoma of the duodenum. In the second case a "perforating lesion" was found low in the jejunum at roentgenologic examination. The lesion could not be removed surgically but jejunojejunostomy was performed after pathologic examination of a specimen of the diseased intestine. Postoperative roentgen therapy was given. The patient died within four months. The

most recent instance was that of a man, forty-four years old, who in twelve months had lost 42 pounds (19.1 kg.). He had had gradually increasing obstructive type of pains in the lower part of the abdomen for more than a year. At roentgenologic examination of the small intestine a constricting deformity was found in the upper part of the jejunum about 22 cm. below the ligament of Treitz (Fig. 4 right). It extended over about 11 cm. of the intestine, and throughout the deformity the mucosal intestine revealed the so-called deficiency state syndrome. Necropsy revealed, however, that the pathologic process was primary in the abdominal lymph nodes, although a long segment of jejunum also was involved in the process, and there were several regions of mucosal ulceration.

Lymphoblastoma of the Large Intestine. There were 6 cases in this series. In 2 the lesions were manifested by colocolic intussusception. In 1 of the cases the lesion was a large (9 by 8 by 4.5 cm.) sessile polypoid

Fig. 5. *Left.* The colon distended with the contrast medium and, *center*, after evacuation of the contrast medium. This is the classical picture of colocolic intussusception and was so interpreted. The patient was a woman thirty-one years old. *Right*, the lesion removed at operation (December, 1934). It proved, at pathologic examination, to be a lymphosarcoma of the cecum which had become invaginated into the transverse colon. The patient received roentgen therapy and was alive and well in October, 1940.

markings were obliterated and the deformity was sharply demarçated at both ends. The roentgenologic diagnosis was carcinoma of the jejunum. At surgical exploration this lesion was found, but there were several other similar ones in the segments of the jejunum aboral to it. Resection was not deemed possible or advisable, but a lateral anastomosis was made short-circuiting the entire diseased intestine. Microscopic examination of a specimen removed from the diseased intestine revealed that it was lymphoblastoma of the Hodgkin's type.

In another instance in which the small intestine was involved with lymphoblastoma the roentgenologic examination of the small lesion situated high in the descending colon, which at the time of roentgenologic examination had become invaginated into the sigmoid colon below it; in the other case, a cecal lesion of sessile polypoid structure measuring 8.5 by 5.5 by 2.5 cm. was present and at the time of roentgenologic examination had become invaginated into the middle segment of the transverse colon (Fig. 5).

In 3 cases the lymphoblastomas of the colon were manifested roentgenologically by encircling types of deformity in different segments of the colon. One lesion involved the sigmoid colon, the other two were found in the cecum and ascending segments. One of the filling defects in the ascending colon

was indistinguishable from that produced by carcinoma, and that diagnosis was rendered at roentgenologic examination (Fig. 6). In the case of a boy, twelve years old, a huge destructive type of lesion was found at roentgenologic examination. The tubular structure of the entire cecum and ascending colon was obliterated by the pathologic process, and no vestige of mucous membrane could be seen in any portion of the involved segments (Fig. 7 left). The deformity did not resemble that of carcinoma in any way, although the evidence for malignant neoplasm was unmistakable. A roentgenologic diagnosis of malignant tumor was offered. At operation the lesion although large could be liberated and removed. The patient received postoperative roentgen therapy and is living and well nine years after operation. In the third of this group of 3 cases an unusually extensive constricting and encircling deformity of the sigmoid was found at roentgenologic examination (Fig. 7 right). The patient was a man, aged forty-three. The changes which the tumor produced in the large intestine

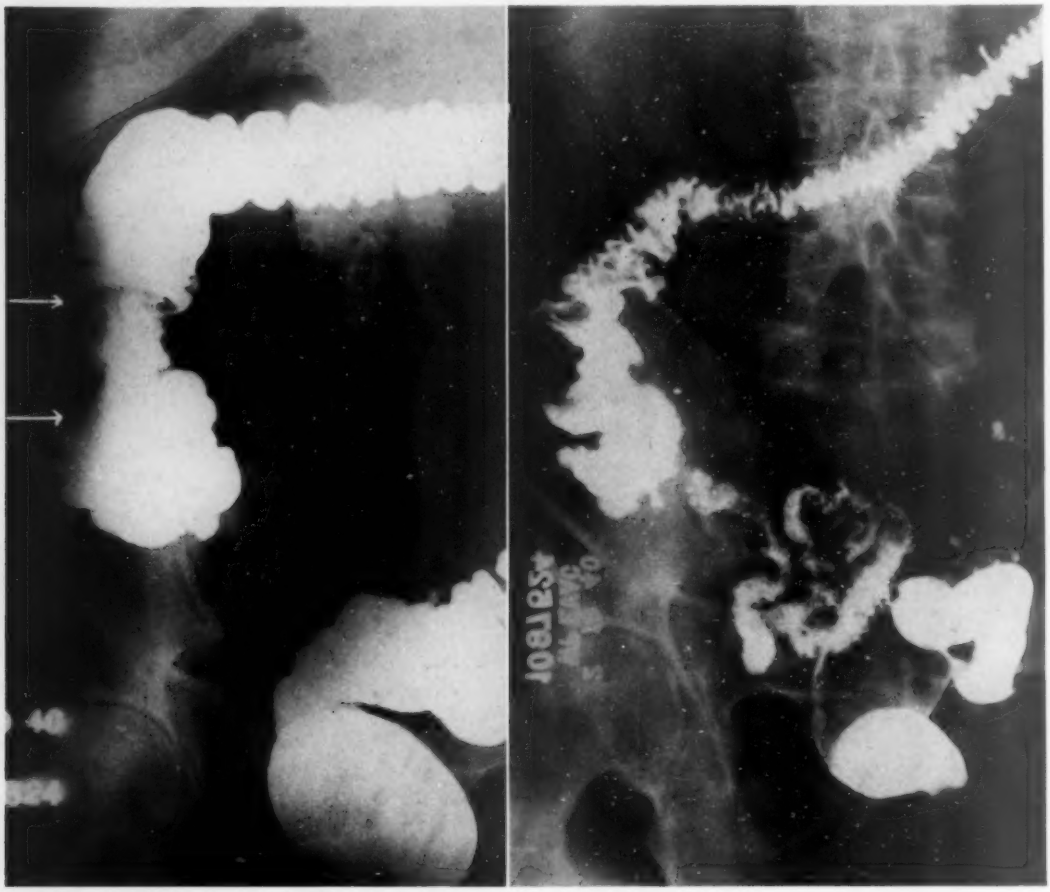

FIG. 6. Roentgenograms of the colon; *left*, distended with the contrast enema and, *right*, after evacuation of the contrast enema. The patient was a man seventy-two years old. The deformity is typical of neoplasm, and the roentgenologic diagnosis was "carcinoma of the ascending colon." The lesion was removed surgically and proved to be an "annular ulcerating lymphosarcoma." The patient received roentgen therapy. He died eight months after operation.

were entirely unlike those which we had ever seen carcinoma produce, so a presumptive roentgenologic diagnosis of lymphosarcoma was offered. The lesion proved to be removable. The pathologic diagnosis was "adenocarcinoma of high grade malig-

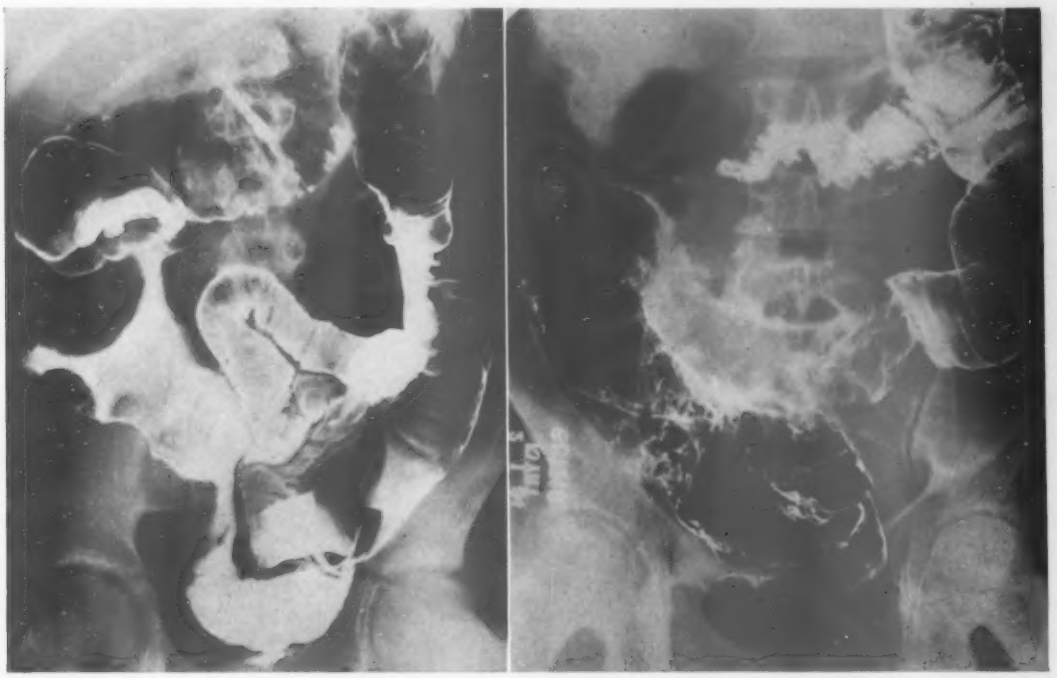

Fig. 7. *Left.* Double contrast roentgenogram of the colon. The roentgenologic diagnosis: "Primary malignant tumor involving the cecum and a large segment of the ascending colon." *Right,* double contrast roentgenogram of the colon showing a long tubular deformity of the sigmoid colon. The presumptive roentgenologic diagnosis was lymphosarcoma of the sigmoid colon. This diagnosis was later substantiated pathologically. The patient was alive and well except for a local recurrence in his wound three years after operation.

nancy imitating lymphosarcoma." The patient received postoperative roentgen therapy. Three years later he returned with a nodule in the operative scar; microscopic examination revealed this nodule to be lymphosarcoma.

The sixth patient in this series was a man, fifty-nine years old, who had no particular complaints except a feeling of pressure in the rectum. Proctoscopic examination revealed many intramucosal nodular masses which were not polypoid in character. A specimen removed for biopsy from one of these masses proved on pathologic diagnosis to be lymphosarcoma. Roentgenologic examination of the colon showed no deforming lesion, but the mucosal relief pattern of the sigmoid, descending colon, cecum and ascending colon was diffusely nodular, and the underlying pathologic process was presumed to be the same as that which proctoscopic examination revealed. The patient received roentgen therapy and intrarectal radium therapy. He died ten months later. Necropsy was not performed to our knowledge, so that the exact nature of this lymphosarcomatous process is unknown.

COMMENT

Ewing made the statement that the literature on the subject of lymphosarcoma of the gastrointestinal tract presents a chaotic picture. The same might well be said of the

roentgenologic literature on the subject, and we wish to be the first to state that we are contributing nothing to ameliorate this situation. Some of the confusion seems to be due to failure to distinguish carefully between lymphoblastomas that arise as primary lesions of the gastrointestinal tract and those in which one or more gastrointestinal lesions are the result of an extension of a neighboring or contiguous lymphoblastomatous process. Some of the peculiar roentgenologic manifestations that have been described are unquestionably instances in which the lymphoblastomatous process was primary in some other organ and the roentgenologic changes observed were either produced by a metastatic lesion or were due to a secondary type of involvement. Some of the instances, too, in which roentgenologic examination of the gastrointestinal tract gave negative results, might be explained in this way. The process, having its origin extrinsic to the gastrointestinal lumen, failed to produce recognizable roentgenologic change in the lumen. It is no longer admitted that primary gastrointestinal lesions, sizable enough to produce symptoms, escape roentgenologic detection when the roentgenologic examination is in competent hands. This does not mean, of course, that the exact histologic nature of the lesion is always predictable on the basis of the roentgenologic findings, but it does mean that the site and the general gross pathologic structure of the lesion can be predicted on the basis of these findings.

Our experience is much like that of others who have had opportunity to observe more than just a few lymphoblastomas of the gastrointestinal tract. In by far the greater number of instances the diagnosis of neoplastic lesion, and generally of malignant neoplastic lesion could be and was offered. When the ratio of incidence of sarcoma to carcinoma (1 sarcoma to 111 carcinomas in a total of 4,159 cases of malignant lesions of the stomach reviewed by Balfour and McCann)[11] is kept in mind, it seems presumptuous indeed to hazard a diagnosis of sarcoma, and especially of lymphosarcoma, unless the roentgenologic manifestations are extremely unusual. Madding and Walters[12] made the statement that "roentgen examination failed to lead to the correct diagnosis in any of" 20 cases of reticulum cell lymphosarcoma of the stomach. Presumably they did not wish to imply that the roentgenologic examination was of negligible assistance in arriving at the final diagnosis for they added that in 15 of the cases the roentgenologic diagnosis was carcinoma, and in 2 ulcer. Balfour and McCann, reviewing the 54 cases of sarcoma of the stomach studied at the Mayo Clinic before July, 1929, observed that following roentgenologic examination diagnoses were offered in 45: malignant lesion in 35 cases; ulcer in 3; extragastric tumor in 2; possible benign tumor in 1 and negative in the rest. Thus even in earlier times during the very developmental period of gastroenterologic roentgenology significant roentgenologic diagnoses were offered in 91 per cent of the cases in which opportunity for examination was given.

After careful deliberation on the results of this review we regret to admit that we have no suggestions to offer as to how to distinguish lymphoblastoma roentgenologically from other types of neoplastic lesions in the gastrointestinal tract. If we may be considered to be competent to form an opinion on the matter, we think that clinical methods have little that is constructive to offer toward improving this rather unhappy diagnostic situation. It is possible that the outlook may be more hopeful in the colon. Its tubular structure is simpler than that of the stomach, and present day methods of roentgenologic examination can be made to depict the pathologic anatomy with unprecedented clarity. It is possible that the gastroscope may shed some light on the problem in the stomach, and it might not be amiss for the roentgenologist to seek the gastroscopist's assistance particularly in instances in which he notes that neoplastic disease is being manifested roentgenologically in a totally unfamiliar manner. In any event roentgenologists can

become more lymphoblastoma-conscious and study the roentgenologic manifestations especially of malignant lesions more carefully and with more attention to detail. Only in this way, it appears, will an independent roentgenologic diagnosis of lymphoblastoma ultimately be achieved.

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DISCUSSION ON PAPERS BY SCHATZKI, PENDERGRASS AND CHAMBERLIN, AND WEBER, KIRKLIN AND PUGH

Dr. Ross Golden, New York. I am not sure whether it is a compliment, but it is certainly a challenge to be asked to discuss these excellent papers in the time of five minutes.

Dr. Schatzki's paper illustrates very nicely what can be accomplished by attention to detail and by careful analysis of shadows. Then Dr. Schatzki skillfully turns to the experimental method to test the fundamental principles of his observations and to clarify them.

I should like to ask Dr. Schatzki whether he noticed any interesting modifications of peristalsis in the esophagus in these cases.

I agree with Dr. Weber on the difficulty of establishing by roentgenologic methods a diagnosis of lymphoblastoma of the gastrointestinal tract. In the stomach we have been wrong in all but two cases in which that possibility was mentioned. In the duodenum the involvement in two instances was several centimeters in length, much more than the ordinary primary carcinoma. The observer in one case—one of our residents—suggested the possibility of lymphoblastoma on that basis.

In the small intestine lymphoblastoma does not produce the marked narrowing characteristic of carcinoma and carcinoid. Certain German writers have mentioned an enlargement of the lumen. Zimmer,* a pathologist, says, "The frequent observation that in lymphosarcoma that involved portion of the intestine shows a widening of the lumen in contrast to the narrowing which occurs almost without exception in carcinoma, . . ." I have seen two cases in which the lumen was not constricted although it was slightly irregular in caliber. On this basis the correct diagnosis was suggested in one of them. In another instance the lumen was narrowed to one-third its normal caliber. I have not seen any other type of malignant tumor in the small intestine fail to produce marked constriction of the lumen. It seems to me that these observations may be helpful in suggesting the possibility of lymphosarcoma of the intestine.

Dr. Pendergrass' paper is particularly challenging and brings up many things which stimulate discussion. The ileogastric reflex is of great interest. Not only does the eating of food stimulate peristalsis in the lower part of the small intestine, but if that region is involved by a pathological process it will produce pain. A reverse ileogastric reflex may occur; the stomach may be emptying continuously and normally until the barium reaches the ileum when the emptying of the stomach may be completely or partially inhibited, and one may find two or three hours later that very little barium has been expelled after the opaque

* Beitrag zur Lymphogranulomatose des Magen-Darmkanals. *Med. Klin.*, 1923, *19*, 681.

material has reached the terminal ileum. This reverse reflex can be taken, I think, as suggestive evidence of trouble in the terminal ileum.

I should like to approve of what Dr. Pendergrass has said about the use of the Miller-Abbott tube. We have found it very helpful. We have yet to see what might be called an obstruction of the small intestine which was actually complete, that is, through which we could not make barium pass after deflation was satisfactorily accomplished. Sometimes it requires a little stimulation, such as inflating and deflating the balloon. In one case I gave a patient an eggnog, which was promptly followed by active peristalsis and barium was forced through the narrowed portion of the lumen.

Tuberculosis of the ileocecal region certainly does occur in the absence of lung involvement. The absence of pulmonary tuberculosis is not of importance in the differential diagnosis between tuberculous and non-tuberculous processes in the intestine.

One rare condition which I have encountered was a nonspecific ulcer of the middle ileum. It produced a narrow constriction about 2 cm. in length which could not be differentiated from a solitary tuberculous ulcer or from a small carcinoma or carcinoid.

I wish to compliment these gentlemen on the excellence of their presentations.

DR. SCHATZKI (closing). I want to thank Dr. Golden for his interesting discussion.

In the large lesions, the peristalsis was not present in the area of the lesion, although it was present on the opposite wall. In the small lesions, the peristalsis did not seem to be disturbed at all as far as one would tell.

In closing, I would like to give a word of warning. Although I think the principles which are laid down in the experiments are correct, I believe it is necessary to warn against abuse by dogmatic clinical application.

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A ROENTGENOLOGIC STUDY OF LOW BACK AND SCIATIC PAIN*

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IN ANY clinical study of low back and sciatic pain, the roentgenograms reveal a variety of developmental and pathologic conditions which may or may not bear a relationship to the factors responsible for the patient's complaints. It is often difficult to determine which changes present on the films are of clinical significance and which are coincidental. This study was made with the purpose of evaluating the various roentgenologic changes noted in cases of low back and sciatic pain by comparing them with the changes noted in a series of control cases none of which presented symptoms of backache.

MATERIAL

The cases of low back and sciatic pain comprised a series of 70 patients. These patients were subjected to thorough clinical study and 62 of them were included in a series treated by one of us (E. A. B.) by means of paravertebral intramuscular injection. The remaining 8 cases were not considered suitable for this type of treatment. All of the patients had complete roentgenologic examinations which included films of the hips and pelvis, dorsal and lumbar spine in the anteroposterior and lateral projections, a lateral view focused over the lumbosacral joint and oblique views of the lumbosacral region taken at an angle of 45 degrees. There were 52 females and 18 males. The ages varied between seventeen and seventy-three. Forty-three cases (60 per cent) were in the fourth and fifth decades.

The control series consisted of patients who did not complain of low back or sciatic pain. Roentgen study identical with that of the backache cases was made. There were 35 patients in this group and the ages varied between fifteen and sixty-three. There were 29 females and 6 males. The age grouping was roughly similar to the backache cases, but there was a larger number of younger individuals in the control group. In addition to the standard films used in the backache cases, this group had lateral views of the lumbosacral joint with the patient standing erect but at the same tube distance.

GENERAL FINDINGS

Table 1 represents the general roentgenologic findings in the two groups and the ratio of the individual findings as noted in the backache and control cases. Most of these will be individually discussed. Of the remainder, it will be noted that changes in the intervertebral discs (except the lumbosacral disc) consisting of slight narrowing or herniation of the nucleus into the adjoining vertebral body occurred in similar proportions in the two groups. Decreased bone density occurred twice as frequently in the backache cases. One of the backache cases presented an associated but coincidental healed Pott's disease. There was no associated bone disease in the control cases. Developmental changes consisting of healed vertebral epiphysitis, osteochondritis, and accompanying calcifications in the anterior spinal ligaments were noted in similar proportions in the two groups. Normal roentgenograms were similarly noted in equal proportions in the control and backache groups.

LUMBOSACRAL ANOMALIES

Table 11 represents the types of lumbosacral anomalies noted and the incidence in the two groups. An anomaly of some type was noted in 48.5 per cent of the cases of both groups. Asymmetrical lumbosacral facets and sacralization of the fifth lumbar

* From the Departments of Orthopedic Surgery and Roentgenology, Jewish Hospital, Philadelphia.

TABLE I

GENERAL ROENTGENOGRAPHIC FINDINGS

	Backache (70)	Control (35)	Ratio
Lumbosacral anomalies	34	17	Same
Hypertrophic arthritis	40	9	2–1
Atrophic arthritis	1	0	1–0
Scoliosis	21	5	2–1
Lordosis increased	7	2	2–1
Lordosis decreased	13	1	6–1
Disc changes (excluding fifth lumbar)	10	5	Same
Bone disease	1	0	1–0
Decreased bone density	4	1	2–1
Developmental changes	10	6	Same
Dorsolumbar changes	31	10	1.5–1
Sacroiliac changes	6	0	6–0
Dorsal changes	32	8	2–1
Lumbar changes	45	6	4–1
Lumbosacral changes (excluding anomalies)	9	1	5–1
Multiple areas involved	54	8	3–1
Blurred or narrow facets	17	10	Same
Sclerotic facets	4	0	4–0
Anomalous facets	18	6	1.5–1
Normal roentgenograms	6	4	Same
Anterior displacement fifth lumbar	1	1	Same
Posterior displacement fifth lumbar	4	0	4–0
Narrow fifth lumbar disc	14	2	3.5–1

vertebra were present slightly more frequently in the backache cases. There were more combined anomalies in the backache group. Sacralization and lumbarization were noted almost entirely in females. Of the 13 patients in both groups presenting these anomalies, only 1 was a male. Other anomalies were found to be evenly divided between the sexes. We could not demonstrate any definite relationship between lumbosacral anomalies and the presence of radiating pain. In the backache group, there were 29 patients who had pain radiating into the groin or leg. In only 10 of these cases was there evidence of lumbosacral anomaly. Conversely, of 34 cases with lumbosacral anomaly, only 10 complained of radiating pain.

There seemed to be no relationship between narrow lumbosacral discs and lumbosacral anomalies. In the backache cases, of 34 cases with anomalies, there were 5 associated narrow discs, but 9 cases of narrow disc were present without anomalies. In the control group, in which there were 17 lumbosacral anomalies, there were 2 cases of narrow disc. No narrow disc existed without an associated lumbosacral anomaly in this group.

HYPERTROPHIC ARTHRITIS

Hypertrophic arthritic changes or osteoarthrosis was present twice as frequently in the backache cases. The changes were evenly distributed between the dorsal and lumbar areas. The significance of this finding is somewhat questionable because there was a higher proportion of patients over the age of fifty in the backache cases than in the controls. It was our definite impression,

TABLE II

LUMBOSACRAL ANOMALIES

	Backache (70)	Control (35)
Spina bifida occulta	14	9
Sacralization fifth lumbar	4	1
Lumbarization first sacral	5	3
Asymmetrical facets	18	6
Impinging spinous processes	0	0
Accessory articular processes	0	0
Spondylolisthesis	1	0
Incomplete neural arch	2	1
Spina bifida and asymmetrical facets	1	1
Spina bifida and sacralization fifth lumbar	1	1
Spina bifida and lumbarization first sacral	2	0
Spina bifida and incomplete neural arch	0	1
Asymmetrical facets and sacralization fifth lumbar	2	0
Asymmetrical facets and lumbarization first sacral	1	0
Asymmetrical facets and incomplete neural arch	1	0
Spina bifida, lumbarization first sacral and asymmetrical facets	1	0

however, that these changes were noted much more frequently in the painful backs.

SCOLIOSIS AND LORDOSIS

Scoliosis and increased lumbar lordosis were present twice as frequently in the group of painful backs. Decreased lordosis with flattening of this area of the spine was seen six times more often in the backache cases than in the controls.

AREA OF INVOLVEMENT

In the 62 backache cases in which a definite clinical diagnosis could be made, there was no direct correlation between the diagnosis and the area on the individual roentgenograms showing the greatest abnormality.

Dorsolumbar changes were present one and one-half times as frequently in the backache cases as in the controls; dorsal changes twice as frequently, and lumbar changes four times as frequently. Multiple areas of involvement were noted in three times as many cases in the backache group. Sacroiliac changes were noted in 6 of the backache cases and in none of the controls. Lumbosacral changes excluding anomalies were noted four and one-half times as frequently in the backache cases as in the controls.

Facet changes, exclusive of asymmetrical facets, were noted chiefly on the oblique lumbosacral films. Blurring or narrowing of the articulations occurred in similar proportions in the two groups. No accessory facets or fracture lines were visible on any film. Sclerosis of the margins of the facets was noted in 4 of the backache cases and in none of the controls. Three of these were associated with hypertrophic arthritic changes in the lumbar spine.

DISPLACEMENT OF FIFTH LUMBAR VERTEBRA

There was one case of grade three spondylolisthesis of the fifth lumbar vertebra in the backache group. In the controls, no instance of true spondylolisthesis was seen, but, in 1 patient, the erect film showed a forward slipping of 4 mm. This was not associated with any defect in the neural arch.

In the backache series, there were 4 patients with definite posterior displacement of the fifth lumbar vertebra. As measured posteriorly, the displacement varied between 4 and 13 mm. In 3 of these cases, the posterior displacement was also noted in the anterior measurement, but the distance was less (2 mm.). In the remaining case the anterior border of the fifth lumbar was found to be slightly anterior to the sacrum. In 2 of the 4 cases we noted associated narrowing of the posterior portion of the fifth lumbar invertebral disc. In the control series no instance of posterior displacement of the fifth lumbar vertebra was seen.

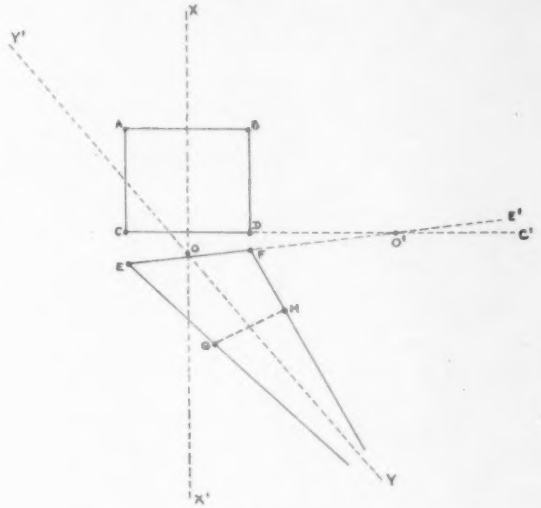

FIG. 1

CE = anterior disc measurement;
DF = posterior disc measurement;
$CO'E$ = disc angle;
XOY = lumbosacral angle.

FIFTH LUMBAR DISC MEASUREMENT, DISC ANGLE AND LUMBOSACRAL ANGLE

An attempt was made to evaluate the importance of the fifth lumbar disc measurements and the angle between the fifth lumbar vertebra and the sacrum in the etiology of low back pain.

Figure 1 represents graphically the method by which these measurements were taken. All were made on the direct lateral roentgenogram. The points *ABCD* are taken at the corners of the fifth lumbar vertebra. The points *EFGH* are taken at the corners of the first sacral segment. The line *XX'* bisects the fifth lumbar vertebra.

TABLE III

FIFTH LUMBAR DISC MEASUREMENTS

	Backache (68)	Control (35)
Female	Average mm.	Average mm.
Anterior measurement		
Recumbent	16.3 (L24 S6)	15.2 (L20 S8)
Erect		15.7 (L23 S8)
Posterior measurement		
Recumbent	6.6 (L10 S0)	6.3 (L9 S4)
Erect		5.7 (L9 S4)
Male		
Anterior measurement		
Recumbent	18.8 (L25 S9)	20.0 (L25 S15)
Erect		20.0 (L27 S16)
Posterior measurement		
Recumbent	6.3 (L10 S3)	6.0 (L7 S5)
Erect		5.3 (L7 S4)

L = largest S = smallest

line *YY'* bisects the first sacral segment. These two lines meet at *O* and form the angle *XOY* which is the lumbosacral angle described by Mitchell. The lower surface of the fifth lumbar vertebra projected backward forms the line *CC'*. The upper surface of the first sacral segment projected backward forms the line *EE'*. These two lines meet at *O'* forming the angle *CO'E* which we have called the disc angle. In the backache series the measurements were made in 68 of the 70 cases. Of those not measured, 1 was an advanced spondylolisthesis and in the other the lateral film was unsatisfactory for measurement.

Table III represents the anterior and posterior disc measurements in the backache and control cases. The *average* measurements are approximately the same in the two groups. In comparing the sexes, it will be noted that the average posterior measurement is about the same in males and females. The average anterior measurement, however, is definitely greater in the males. This would tend to produce an increased disc angle which might cause lessened stability of the lumbosacral joint with predisposition to strain. In the erect position, a slight decrease in the average posterior disc measurement was noted, but this was not enough to be of clinical significance.

As a result of all these measurements, it was felt that an arbitrary standard minimum of 5 mm. be set for the posterior disc measurement in both males and females. A standard anterior disc measurement was set at 13 mm. in females and 18 mm. in males. Using these standards, 2 of 35 (5.7 per cent) of the control cases had narrow posterior discs. Both of these were females (6.9 per cent). In the backache cases, 14 of 68 (20.6 per cent) had narrow posterior disc measurements. Five were in males (27.7 per cent) and 9 were in females (18 per cent).

In the case of the anterior disc measurement, in the backache group 13 of 68 (19.1 per cent) had narrow discs, and 6 of 35 control cases (17.1 per cent) presented this finding. The narrowing was present in males in a much higher proportion than in females and the proportion was the same in the backache and control groups. In the backache cases, anterior narrowing alone was present in 5, posterior alone in 6, and both anterior and posterior narrowing in 8. In the controls, anterior narrowing alone was present in 5, posterior alone in 1, and both measurements were narrowed in 1 case. It would seem, then, that anterior

disc narrowing is of little clinical significance unless it is associated with a decrease in posterior measurement. Anterior narrowing would also be unimportant in altering the disc and lumbosacral angle to the point where they might produce increased instability and strain.

In the backache cases, posterior narrowing of the disc was noted in only 1 case of 10 patients under the age of thirty-one, while it was present in 13 patients of 58 above the age of thirty. In the controls, 1 patient was aged twenty-three and the other forty-five.

Of the 68 backache cases, there were 20 patients with sciatic radiation of pain. In only 5 of these was there evidence of a narrow posterior disc measurement. Conversely, of 14 patients with narrow posterior discs, 8 presented no radiation of pain, 5 complained of radiation in the sciatic distribution, and in 1, the radiation was into the groin and anterior thigh.

Table IV represents the disc angles in the backache cases and in the controls. The average disc angle in both groups is greater in males than in females due to the proportionally greater anterior disc measurement. A comparison of the two groups, however, shows little difference in the average disc angle. In the males, the average disc angle is slightly less in the backache group. This is due to the decreased average anterior disc measurement in the males of the backache group and is of no clinical significance. In the control cases, we could demonstrate no definite change in the disc angle in the erect position. In 17, the angle was increased; in 14, it was decreased; and in 4, it remained the same. One would expect more change in the disc angle in this position.

A standard maximum disc angle was set at 25 degrees in males and 20 degrees in females. Using this standard, in the control cases 6 of 35 (17 per cent) showed an increased disc angle. There was 1 male of 6 (16.6 per cent) and 5 females of 29 (17.2 per cent). In the backache cases, 7 of 68 (10.3 per cent) showed an increased disc angle. There were no males in this category in the series of 18, but there were 7 females of 50 (14 per cent). Increased disc angle occurred without narrow posterior disc measurement in 5 of 6 controls and in 4 of 7 backache cases. Furthermore, a decreased posterior disc measurement was not usually associated with an increased disc angle. In 9 of the 14 backache cases with narrow posterior disc measurement there was associated narrowing of the anterior disc which made the disc angle measurement less than the standard maximum. In 2 other cases without associated anterior narrowing, there was also no increase in the disc angle. Increased disc angle would therefore seem to be of no diagnostic importance in the etiology of low back and sciatic pain.

TABLE IV

DISC ANGLE

	Backache (68)	Control (35)
Female	Average Degrees	Average Degrees
Recumbent	16.4 (L37 S4)	16.0 (L26 S6)
Erect		16.8 (L30 S5)
Male		
Recumbent	19.0 (L25 S12)	22.0 (L30 S15)
Erect		21.0 (L30 S14)

L = largest S = smallest

Table V represents the average lumbosacral angles in the two groups. There is no significant difference between the backache and control cases in either males or females. In the series of painless backs, the erect position did not alter the average lumbosacral angle. In the individual cases, 14 were decreased, 18 were increased and 3 remained the same.

If a standard minimum lumbosacral angle is set at 130 degrees, there were 13 abnormal angles (19.1 per cent) in the back-

ache group and 5 (14.3 per cent) in the control group. No relationship between decreased lumbosacral angle, narrow posterior disc and increased disc angle could be shown. In the backache and control series, decrease in lumbosacral angle was not associated in any case with a narrow posterior disc. Of the 13 cases with increased disc angle, there was a corresponding subminimal lumbosacral angle in only 4. It would seem, then, that a decreased lumbosacral angle is not an index of strain in the production of low back pain. Increased lumbar lordosis was noted in only 2 of the 13 backache cases with decreased lumbosacral angle. In 10 the lumbar curve was considered normal and in 1 it was flattened.

TABLE V

LUMBOSACRAL ANGLE

	Backache (68)	Control (35)
Female	Average Degrees	Average Degrees
Recumbent	137.2 (L162 S123)	134.6 (L155 S125)
Erect		134.5 (L159 S122)
Male		
Recumbent	135.0 (L148 S126)	135.0 (L146 S124)
Erect		133.5 (L146 S125)

L = largest S = smallest

SUMMARY

A comparison of the roentgenologic studies in 70 cases of low back pain and 35 painless backs reveals the following observations:

1. Normal roentgenograms, vertebral epiphysitis and osteochondritis, narrowing of the intervertebral discs (except the fifth lumbar) and vertical herniation of the nucleus pulposus are noted in similar proportions in the two groups.

2. Lumbosacral anomalies are present in 48.5 per cent of the backache and control groups. There is no relationship between the presence of lumbosacral anomalies and the incidence of radiating pain. Anomalies are apparently unrelated to the presence of narrow posterior fifth lumbar disc measurement.

3. Lumbarization of the first sacral segment and sacralization of the fifth lumbar vertebra are noted almost entirely in females.

4. Hypertrophic arthritis of the spine is noted twice as frequently in the backache cases.

5. Scoliosis and increased lumbar lordosis are noted twice as frequently in the backache cases as in the controls. Flattening of the lumbar spine occurs six times as frequently in the backache cases.

6. There is no direct relationship between the clinical diagnoses and the areas on the roentgenograms showing the most marked abnormality. The roentgenologic changes do not necessarily represent the cause of the patient's complaints.

7. Lumbar abnormalities are noted four times as frequently in the backache cases as in the controls. Lumbosacral abnormalities are present four and one-half times as frequently.

8. Sacroiliac changes are present in the roentgenograms of six of the backache cases and in none of the control cases.

9. The oblique films of the articular facets in these two series of cases reveal no information of diagnostic importance. Blurring and narrowing of the articulations are present in similar proportions in the two groups. No accessory facets, subluxations, nor fracture lines are noted. Sclerosis of the facet margins is present in four cases of the backache group. Three of these are associated with definite hypertrophic arthritic changes which are readily seen on the other views.

10. There are four patients with posterior displacement of the fifth lumbar vertebra in the backache group. None is noted in the controls.

11. The average posterior measurement of the fifth lumbar disc is the same in males and females. The average anterior measurement is greater in males. In the erect position there is no significant change in the disc measurement.

12. Narrow posterior disc measurement is noted in 20.6 per cent of the backache cases and in 5.7 per cent of the controls. This finding is present much more frequently in patients over the age of thirty. There is no relationship between narrow posterior disc measurement and the incidence of radiating leg pain.

13. Narrow anterior disc measurement appears in about equal proportions in the two groups and is probably of little significance unless the posterior disc measurement is also narrowed.

14. The disc angle and the lumbosacral angle measurements show no significant differences in the backache and in the control groups. There is no definite relationship between these angles and posterior fifth lumbar disc measurement. The angles are not significantly altered by the erect position. An increased disc angle or a decreased lumbosacral angle is not an index of susceptibility to strain with the development of low back pain.

15. Narrow posterior fifth lumbar disc measurement and posterior displacement of the fifth lumbar vertebra as recognized on the roentgenogram appear to be definite etiologic factors in the production of low back and sciatic pain.

16. Extreme caution should be used in interpreting lumbosacral anomalies, vertebral osteochondritis and epiphysitis, vertical displacement of the nucleus pulposus, narrowing of the lumbosacral facets and alterations in the lumbosacral angle as etiologic factors in low back and sciatic pain.

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MULTIPLE PRIMARY HEMANGIOMA OF THE BONES OF THE EXTREMITY

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BUCY and Capp[1] in 1930 collected 47 cases of proved symptomatic primary hemangioma of bones. Geschickter and Maseritz,[2] in a supplementary report, collected 49 references pertaining to primary hemangioma of bone. In the latter, the authors found no proved cases involving bones of the extremities and the report of Bucy and Capp included but 11 cases in which bones of the extremity were involved. To this number Geschickter and Maseritz have added 4 cases of symptomatic primary hemangiomas involving bones of the extremities observed by them, bringing the total number of reported cases to 15.

Due to the relative rarity of this tumor, and because we have had an opportunity of following a case for nearly ten years, we feel justified in adding another case of primary multiple hemangioma of the bones of the extremity to the literature.

CASE REPORT

C. W. (Hosp. No. 51106), a white male, aged fifteen, entered the University Hospital in August, 1930, with the history of progressive, painless swelling of the left ankle and knee for the past four years. About eighteen months prior to admission the patient stepped in a hole and injured his left ankle, and from that time on was compelled to use crutches. There was no diagnosis nor treatment prior to admission. The past history was otherwise essentially negative. The general physical examination was negative. The patient appeared to be a normally developed boy and not acutely ill. The local physical examination showed a uniform non-tender enlargement of the left ankle and a fusiform non-tender swelling of the left leg just below the knee. There was marked limitation of motion of the ankle, but none of the knee. There was no local elevation of temperature nor discoloration. A slight atrophy of the muscles of the left leg was noted. No definite inguinal adenopathy could be demonstrated. Red blood count 4,600,000, white blood count 7,400, neutrophiles 68 per cent, lymphocytes 32 per cent; Wassermann reaction negative. Urinalysis negative. Blood calcium 10.4 mg. per 100 cc.

Roentgen examination of the left leg showed a fusiform widening of the proximal diaphysis of the tibia, about 4 cm. below the epiphyseal line. Coarse bone trabeculae arising from a center of the medullary portion of the bone extended radially toward the periphery, where they became less dense, and more widely separated. The cortex of the involved segment was thin, its medullary border somewhat irregular. The periosteum remained intact. In the long axis of the shaft there was no sharp demarcation of the tumor from the normal bone. Proximally and distally the bone trabeculae of the tumor merged with the normal bone trabeculae. Similar coarse bone trabeculations of increased density were demonstrable within the proximal segment of the shaft of the fibula about 2 cm. below the epiphyseal line. The fibula was slightly widened. A third lesion involved the distal third of the shaft of the tibia. The inferior border of this lesion was sharply demarcated by the epiphyseal line. The shaft showed a fusiform swelling and the bone trabeculae were coarse and of increased density. They appeared to arise in the center of the medullary portion of the bone and from there radiated toward the periphery. There were several locules within the involved bone traversed by rather thick and dense bone trabeculae. The lower end of the fibula was thin, the medullary canal narrowed, evidently due to pressure.

A biopsy was taken from the distal tibia and a microscopic diagnosis of osteitis fibrosa was made. The case was submitted to the Bone Tumor Registry and the diagnosis of osteitis fibrosa was confirmed (Reg. No. 1361). However, one member of the committee suggested angioma of the bone, and on recirculation of the case, the diagnosis was changed from osteitis fibrosa to primary angioma.

The patient was seen at frequent intervals for the next six years. During that time no

FIG. 1. Multiple hemangioma involving the proximal and distal end of the shaft of the tibia and proximal end of the shaft of the fibula.

definite progress of the disease could be observed and the patient carried on normal activity without the aid of crutches. There was no treatment other than palliative measures. Thereafter, the patient failed to report for about three years, but in April, 1940, he returned to the out-patient department of the University Hospital complaining of increased enlargement of the left ankle with considerable pain necessitating the use of crutches again. Physical examination at this time revealed more swelling of the left ankle with marked tenderness and slight local elevation of temperature and discoloration. The lesion of the proximal tibia showed no gross changes from the last examination. The general physical examination remained essentially negative.

Roentgenograms of the left leg and foot were taken. There was a marked fusiform enlargement of the proximal third of the tibial diaphysis. The bone presented a considerably increased density, obliterating completely the medullary canal. The coarse bone trabeculae presented quite an irregular arrangement, and were less widely separated than on the original examination. A small portion of the tumor extended beyond the medial border of the old cortex of the shaft, and encroached on the fibula. The periosteal border of the cortex was irregular; the cortex showed several loculated areas subperiosteally. The superior border of the tumor was fairly sharply demarcated from the surrounding normal bone, whereas the inferior border seemed to merge into the normal bone without sharp delineation. There was also a fairly sharply defined area of increased density within the tibial epiphysis underneath the intercondylar tuberosity. The proximal end of the fibula, which previously showed the described changes, was markedly thinner, due to pressure exerted by the enlarged tibia. No neoplastic changes could be demonstrated, with the exception of a small rarefaction of the medulla, just below the compressed segment. The lower end of the tibia increased considerably in thickness, as compared with the previous examination. The central portion was particularly dense, and the arrangement of the bone trabeculae was quite irregular. There were several

FIG. 2. Increased expansion and marked sclerosis of the tibia; pressure atrophy of the proximal third of the fibula. Note the disappearance of the hemangiomatous changes within the fibula.

small loculated areas within the cortex, which showed an irregular subperiosteal surface. Also the bones of the foot were involved. The tarsal bones presented a definite honeycomb appearance, and there was some expansion of the tarsal bones. The deformity of the talus and cuboid bone was particularly marked. The fourth metatarsal was short, and definitely expanded. There was a central cyst-like area within the distal third of the shaft, traversed by numerous bone trabeculae. The medullary border of the cortex was irregular; the periosteum remained intact. The lesion did not involve the head of the metatarsal.

Fig. 3. Sclerosis of the central lesion of the tibia; numerous peripheral loculations.

Fig. 4. Extensive involvement of the tarsal bones, which show coarse interlacing trabeculations, similar to those found in hemangioma of the spine.

PATHOLOGY

The term "endothelioma" was first applied by Golgi in 1869 to designate a tumor arising from the cells of the smallest capillaries.[3] To determine whether or not one is dealing with a true neoplasm or merely an "angiomatous reaction" is no easy matter. Ewing[4] has this to say concerning angiomas:

> The supply of vessels in a tissue or organ varies extremely in both normal and pathological conditions. Not being composed of a simple tissue, tumors of vessels must be organoid in character. The growth of vessels is markedly influenced by the elements of mechanical pressure of the circulation, which is absent in other tumors. Finally, the nutrition of vessels, especially of those subject to tumor growth, is provided in a different manner from that existing in other tissues. Thus the physiology of vessels necessitates special standards in the interpretation of tumor processes, and has thus led to much difference of opinion as to what constitutes an angioma.

The gross pathology varies. In reviewing the registered cases of primary angioma of bone from the Bone Tumor Registry, we were impressed with the variations in location and characteristics of the tumor. Apparently no bone is exempt. In many instances, it is difficult or impossible to tell whether the tumor had its origin in the bone proper or in the soft tissues surrounding bone. Primary angioma of bone, how-

FIG. 5. Cyst-like area of rarefaction within the shaft of the fourth metatarsal, with expansion of the shaft.

ever, usually causes a more or less uniform expansion of the bone with the formation of multiple cystic cavities of various size, filled with a bloody fluid. The capsule is much more indistinct than is ordinarily seen in giant cell tumors or bone cysts. The epiphysis is usually spared, and in most instances, the cortex remains intact, but may become extremely thin.

The microscopic pathology is quite characteristic. According to Geschickter and Maseritz[2] the cases reported in the literature were for the most part of the cavernous type. The histopathology of this type presents large irregular endothelial-lined spaces filled with red blood cells. The cavernous spaces are separated by compact fibrous tissue. Malignant angioma or angiosarcoma is characterized by solid masses of endothelial cells infiltrating the stroma. The tumor cells are usually remarkably uniform in size, shape, and staining qualities, but there may be marked variations in the cellularity of the tumor in different areas.

The microscopic pathology of the case herein presented showed many irregular spaces lined by a single row of endothelial cells. There was a rather marked infiltration of lymphocytes throughout the fibrous stroma, which in many areas showed advanced degenerative changes. In no areas did it resemble the stoma of a giant cell tumor. There were scattered small fragments of cortical bone without any definite evidence of active osteoplasia.

ROENTGENOLOGY

Since the first description of the roentgen manifestations of hemangioma of bone by Hitzrot[5] sufficient material has been accumulated and studied to allow a more definite evaluation of the roentgenological semeiology, evidenced by these tumors. Of special significance was the work of Bucy and Capp, who reviewed a fairly large series of cases and defined the essential roentgen diagnostic criteria of these tumors.

Hemangiomas of the long bones produce a fusiform enlargement of the epiphyseal ends of the bones or those segments of the shaft in close proximity to the nutrient artery. The tumor is of central origin, and as it enlarges in size, causes the bone to expand. The medullary border of the cortex is usually irregular due to extension of the tumor into the cortex. The bone trabeculae within the tumor are coarse and denser than the normal cancellous bone. These trabeculations may arise in one center, from which the osseous plates spread radially, with a resulting "sunburst" appearance. The involved bone is often loculated. The loculations occur most frequently within the cortex; they are of small size, and irregular appearance. Of diagnostic sig-

nificance is the heavy framework of these locules, because it is not encountered in other bone tumors, which may have to be considered in the differential diagnosis. Within the individual locules a fine fibrillary framework can be discerned. The cortex is usually not expanded, but is partially eroded. The periosteum may be considerably elevated beyond the level of the cortex, but remains intact. The tumor does not involve the epiphyseal cartilage and does not penetrate into the joints.

Studying the cases reported in the literature, one is impressed with the fact that many hemangiomas of the bone do not cause clinical symptoms. Frequently, there is a very definite relation between the onset of symptoms and a trauma. In cases, in which the bones of the extremities are involved, the enlargement of the affected limb may be the only clinical sign of disease.

Fig. 6. Low magnification: Multiple, irregular spaces lined by a single row of endothelium. Stroma consists primarily of loose fibrous tissue, although in some areas there is an attempt at vessel or capillary formation.*

* We are indebted to Dr. Frank T. Siebert for the photomicrographs.

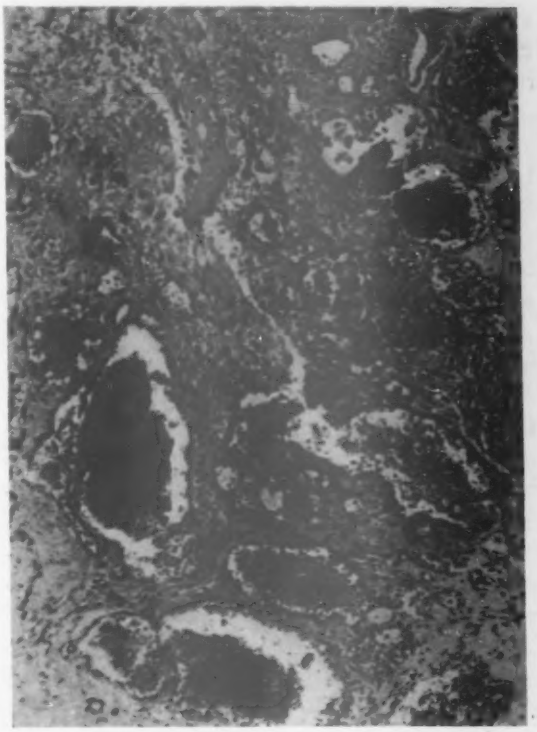

Fig. 7. Low magnification: Large endothelial-lined spaces packed with red blood cells. Stroma shows a moderate lymphocytic infiltration.

The chronic asymptomatic course of the disease makes it difficult to detect the early roentgen manifestations within the bone. It is therefore impossible to determine definitely the probable cycle of alterations of the normal bone architecture in their physiopathological sequence. That the bone changes are of a fluctuating character is more than likely.

A careful study of the second case of Bucy and Capp showed at first a large defect in the neck of the scapula near the glenoid cavity and very few radiating bony trabeculae of increased density. Within one year the original defect had apparently been filled with new, large, coarse bone trabeculae, presenting a characteristic "sunburst" appearance. The entire lesion had increased in size. One year later the tumor was even larger; numerous large

trabeculae arising from a common center radiated mostly at right angles to the plane of the bone. The tumor involved the coracoid process, the root of the scapular spine, the glenoid cavity, and a large portion of the scapular plate. Following roentgen therapy there was a further marked increase in the number and thickness of the bone trabeculae; the bone outline was much more definite.

The case observed by us over a period of ten years exhibits similar characteristics. At first the bone trabeculae formed a rather wide network, which at the periphery assumed the appearance of a loculated lesion. As time went on the bone trabeculae became denser, and the locular spaces decreased in size, until at the last examination, they were confined solely to the subperiosteal surface of the cortex. Since the bone has definitely expanded in the chronic course of this disease, it may be assumed that these cortical loculations present relatively early angiomatous changes, whereas the central portion of the lesion has reossified. The bone which has been laid down within the tumor shows obvious structural deviations from the normal cancellous bone. The recent lesion within the metatarsal is in definite contrast with the changes of the older lesions of the tibia and fibula. We are unable to explain what effect the pressure of the expanding tibial tumor had on the proximal fibula, which originally presented similar neoplastic changes. Even though there is no roentgen evidence of bone pathology, we are not inclined to believe that a complete restitution took place.

The realization of the destructive and productive component within the bone hemangiomas seems to be not only of diagnostic importance but the prognosis and therapy must undoubtedly be influenced by their recognition. The prognosis in the presence of true bone hemangioma is favorable. Most cases reviewed in the literature were benign neoplasms both clinically and histopathologically.

The treatment of choice of bone hemangiomas has thus far been irradiation. Complete cures have been reported in a number of instances. Codman suggested that after irradiation osteoblastic activity of the cells predominates, so that osteoplasia occurs and osteolysis ceases. Roentgen rays exert also a definite effect on the endothelium of the vascular channels, causing a fibrosis. Obviously this effect of irradiation on hemangiomas will alleviate the subjective complaints and may cause an arrest of growth of the pathologically benign neoplastic tissue.

It seems doubtful whether irradiation changes considerably the physiopathological tendencies of the tumor which spontaneously exhibits a rather marked osteoblastic activity after the initial osteolytic phase. It would therefore seem to us that the cases which show a predominance of osteoblastic activity do not necessarily require roentgen therapy. It should rather be reserved for those cases in which osteolysis prevails. Further observations will be required to determine whether irradiation of bone hemangiomas with osteolysis predominating is capable of producing a similar sclerosis, as is observed in cases with definite osteoplastic tendency of the bone, and in which spontaneous healing sometimes occurs.

SUMMARY

A case of primary multiple hemangioma of the bones of the extremity is added to the literature, with a short discussion pertaining to some of the pathological, roentgenological and radiation aspects of this interesting tumor.

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Vol. 48, No. 1

COMPARATIVE STUDY OF THE NORMAL LUNG IMAGE BY TELEROENTGENOGRAPHY AND ROENTGEN KYMOGRAPHY*

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TO DETERMINE the exact limits of the normal lung outline is a difficult task, but its importance is so great that, without it, it is impossible to approach with any probability of success the difficult but intriguing problem of the pathological lung image. A knowledge of the normal image, in all fields of roentgenography, is the best way of reaching a correct interpretation of the abnormal image. Slight or no familiarity with the multitudinous variations which may occur within the normal limits of the lung image is the cause of the interminable chain of errors which is constantly removing us farther from a true interpretation. Many diagnoses of tuberculosis, silicosis and pneumoconiosis, to mention only respiratory pathological conditions, have had no other basis than the mistake of ignoring the complexity of the lung outline and the variations which it may present even under normal conditions. The efforts made so far to determine the limits of the normal and the beginnings of the pathological have enabled us to become oriented with greater safety in determining old errors and to establish foundations to give firmness to our roentgen interpretations.

We have chosen as the subject of this paper that of the normal lung image and its determination because we are convinced that in this most interesting field of roentgenology serious errors of interpretation are often committed in confusing normal with pathological conditions or allowing pathological conditions to pass unnoticed, resulting in serious danger to the patient.

To me it seems certain that it is necessary to be able to explain at any given moment the nature of the elements which enter into the formation of any given shadow of the lung, for it is only in this way that we can form a better idea of the elements and organs that have undergone changes, of which the shadow is only a manifestation. The reliability of a method and its choice over other methods depend on the possibility of making this demonstration.

The great vascular network of the lung, the tracheobronchial tree, the lymphatic system, the connective tissue of both these systems and the bones and soft parts of the thorax, combine in multiple forms to contribute, some in greater and some in lesser degree, to the formation of the normal lung outline. The combination of these organs and structures produces the roentgen image, that which we may call the roentgen lung.

The various authors who have studied the lung outline, whether they believe in the predominance of the vascular system or the bronchial system, have established theories, based on experimental facts, which clearly explain their points of view. Many of these studies have been based on the intensification or, on the contrary, the elimination of one or the other of the two systems, bronchial or vascular, making roentgenograms of them and comparing the results. However much we may believe at present that all those theories which do not hold that the lung outline is caused by the vessels have been disproved, we believe nevertheless that the study that we are presenting here, based on registration of the pulse beat, settles a much debated problem in a clearer way than has been done heretofore and one easier to apply in practice.

The images which I present as a basis for the discussion belong to a group of individuals of both sexes, chiefly male, apparently in good health, with the age,

* Translated from the Spanish by Audrey G. Morgan, M.D.

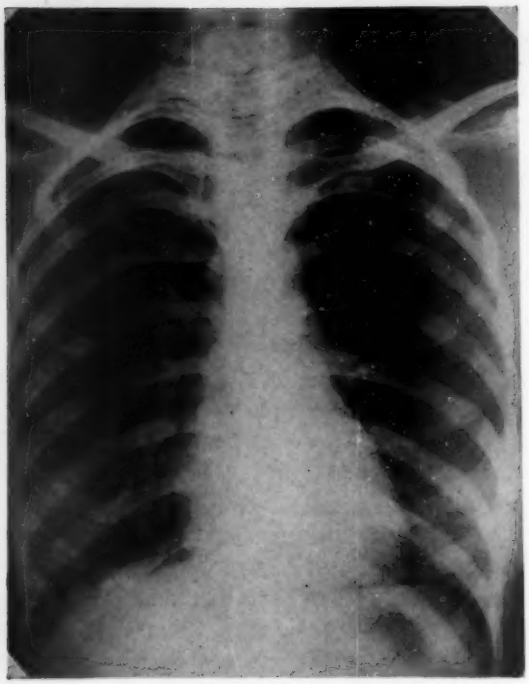

FIG. 1. Teleroentgenogram of the case shown in Figure 2.

weight and height noted. Two images of each individual were obtained: one teleroentgenographic image at a distance of 2 meters and a roentgen kymogram of the same person; in this way we can compare the images to bring out the advantages which we have discovered in the course of this work. The projection was dorsoventral. The different factors in technique varied with each individual case.

NATURE OF THE NORMAL LUNG IMAGE. THEORIES WHICH EXPLAIN IT. VASCULAR THEORY

The lung image is made up of arborizations which start from the hilar organs and regions of Engel, and run, decreasing in intensity, toward the periphery and the apices, but becoming intensified, on the contrary, toward the bases, particularly the internal parts. This image is called by the Germans the roentgen reticulum of the lung. The determination of the nature of this image is fundamentally what caused my desire to present this work, which is concerned exclusively with this subject.

It is generally accepted that the lung outline is produced by the silhouette of the arteries and veins which ramify inside the lung. Nevertheless other authors have thought differently, and therefore we are obliged to consider, even if only briefly, the theories that are not accepted.

Some authors believe that the lung image is fundamentally vascular (vascular theory), others that it is bronchial (bronchial theory), and still others think that both systems are involved (mixed theory). At present it is fully accepted that the lung image is of vascular origin. We shall discuss particularly the vascular theory, which is the one most interesting from the point of view from which I am working, namely that of roentgen kymography.

THE VASCULAR THEORY. FACTS ON WHICH IT IS FOUNDED

This theory, originally supported by Rieder, Holzknecht, Miller and Cohn, and others, was in reality well established by Assmann and it is now accepted by all as

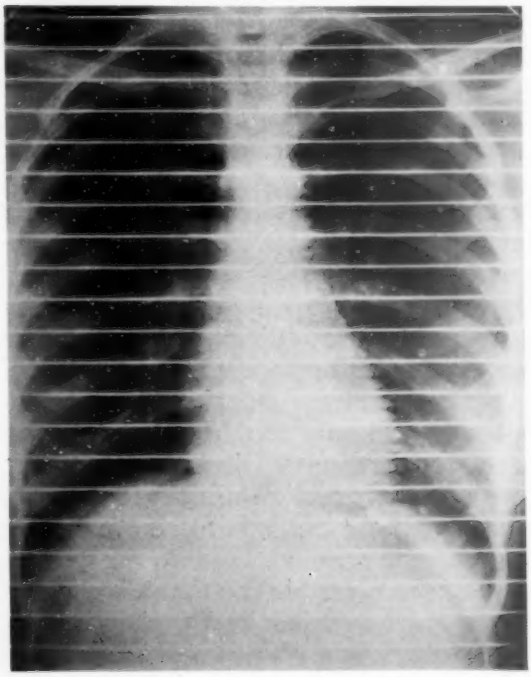

FIG. 2. Plane roentgen kymogram corresponding to Figure 1. Note the pulsation.

best explaining the lung outline. To clear up the origin of the lung outline, studies were made of anatomical specimens separated from the cadaver; in this way it was easy to inject radiopaque substances or air into the vascular and bronchial systems. This method was not very appropriate for the end desired because the ramifications of the vascular and bronchial systems are so close together in the lung and there is frequently such an intimate connection between the two systems that it is impossible to individualize them. But the method of intensifying, suppressing or attenuating one of the two systems, vascular or bronchial, later obtaining the necessary roentgenograms and comparing the images, is well founded. A very conclusive experiment made by Assmann was as follows: By means of technical details, which I will not describe, he filled the vascular system of the right lung in a dog, killed the animal and removed both lungs and the heart; he then washed the left lung until it was completely empty of blood, took a roentgenogram and found in the right lung a network formed by

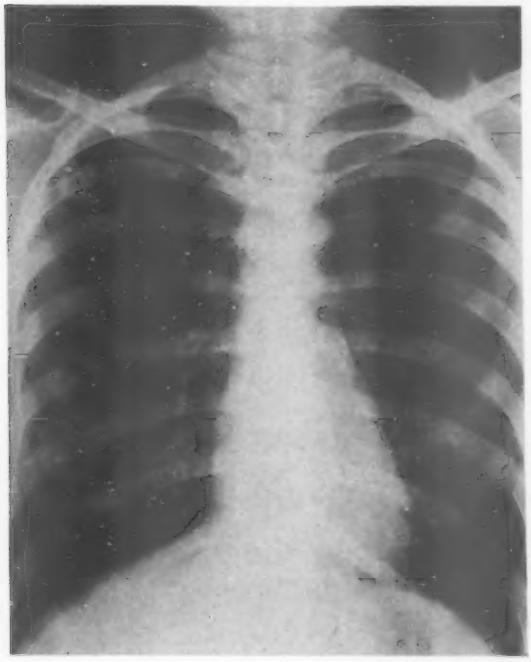

Fig. 3. For the functional examination of this image see Figure 4.

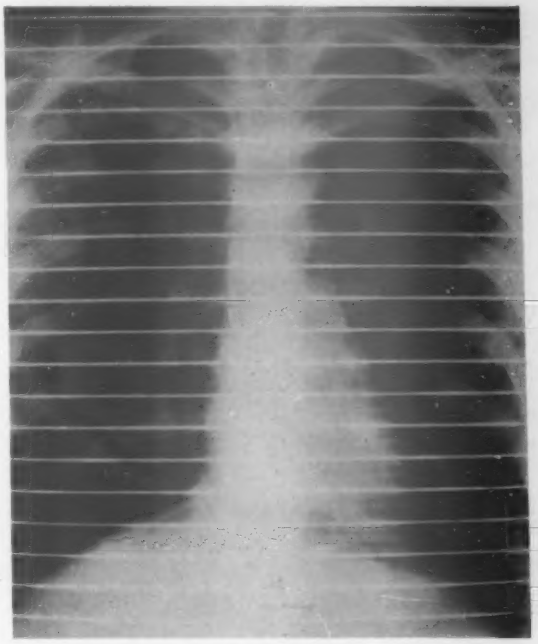

Fig. 4. Roentgen kymogram of Figure 3.

many compact stripes of shadow of uniform density which decreased in size as the distance from the hilar zone increased. This outline was lacking in the left lung, in which there was only a shadow made up of very fine parallel stripes, separated by an intermediate transparent band. This experiment, made by intensifying the vessel image of the right lung by filling it with blood and suppressing that of the left lung by washing, made it possible to differentiate between the shadows of the vascular and bronchial systems, the former showing a shadow band of uniform density, the caliber of which decreased toward the periphery of the lung, and the bronchial system showing parallel longitudinal bands, very slight and separated by a clear air space. At the same time it showed that the greater the amount of blood contained in the vascular system, the more pronounced the roentgen image. This fact was also shown by the experiments of Lorey and Fraenkel, who injected blood into the veins of a cadaver and found that the lung outline was increased and, on the contrary, it was decreased in intensity when blood was withdrawn.

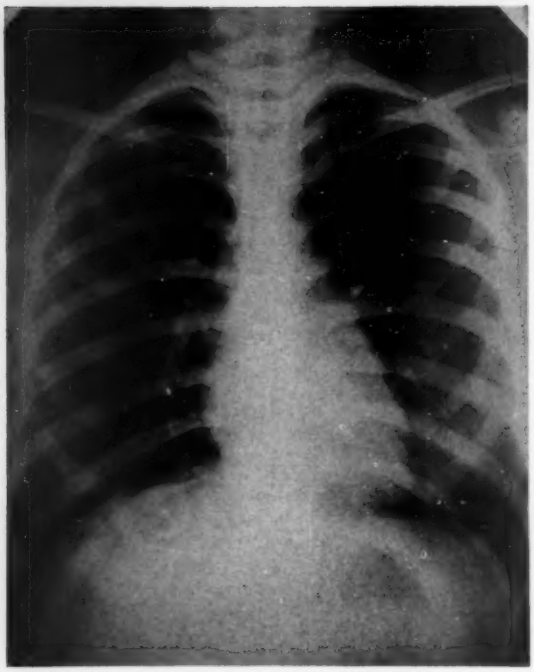

FIG. 5. For functional examination see Figure 6.

Hampton and Castleman,[1] in a recent roentgen study of the lung before and after death in a patient with normal lungs, found great changes in the lung image. In the postmortem examination the blood vessels were small and not very clearly differentiable, the aorta was small, reduced to one-half its normal diameter, the heart contracted or dilated. The difference in these roentgenograms was explained by the change in form and decrease in size of the vessel shadows. According to the studies of von Dehn and Assmann the striped outline of the lung is more marked in the living than in the dead. In making our roentgenograms we frequently found very marked outlines in persons who had circulatory disturbances of central origin; in some cases of heart disease the lung outline was strongly visible. Another evidence of the vascular nature of the lung shadow is that when certain radiopaque substances are injected into the circulation there is an increase in the roentgenological lung outline. The introduction into the bronchi by Weber and Owen of objects such as birdshot showed that these bodies occupied the site of a bronchus, while beside and independent of this chain of metal the vascular shadow persisted. However, they did not demonstrate or discover one of the best applications of the method of opacification by means of lipiodol of Sicard and Forestier—bronchography. It was discovered accidentally in cases of esophagobronchial fistula from cancer of the esophagus that on passing the bismuth into the bronchi they were rendered visible, and beside their shadow there was another shadow, completely independent of them, produced by the vessels. Later, when completely adapted to this purpose, bronchography showed the independence of the shadows by persistence of the vessel bands, in spite of the great coefficient of absorption of lipiodol for roentgen rays.

If we study lung images carefully we do not see a system of parallel longitudinal bands separated by clear spaces, which

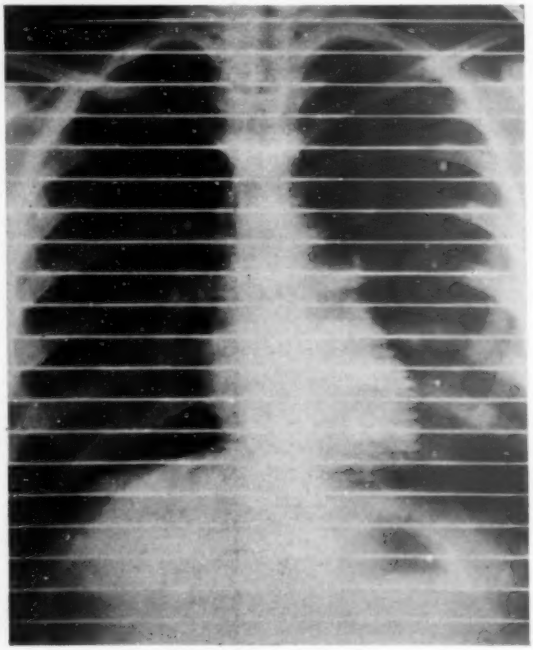

FIG. 6. Same case as Figure 5.

[1] Hampton, A. O., and Castleman, B. Correlation of postmortem chest teleroentgenograms with autopsy findings. AM. J. ROENTGENOL. & RAD. THERAPY, 1940, *43*, 305.

would be the manifestation of the bronchial system but, on the contrary, a well defined system of regular bands of more or less dense shadow, which indicates predominance of the vessels. A point that we should note is that the vessels decrease in caliber as they approach the periphery while the bronchi remain of the same size until they reach a new bifurcation.

Having made the preceding observations, which convince me of the vascular nature of the lung outline, I will refer to the roentgen kymographic method as a more accurate method and one of immediate and harmless application.

ROENTGEN KYMOGRAPHIC METHOD

I will begin by saying that I use the method of a movable grid, or plane roentgen kymography, for the other method with a fixed grid, which is accurate for the registration of motility, does not permit of identification of the point of origin of the shadows as the form of the organs is lost.

As the roentgen kymographic method is a relatively new method in roentgenography and as fundamentally it gives information of a functional nature, relating to motility, I cannot see why it has not already been used to demonstrate the vascular nature of the lung outline. If the systolic-diastolic image of the heart and aorta is registered so faithfully why would not the vessel branches, endowed with the same kind of movement, be registered with equal accuracy?

Fig. 7. See Figure 8 for the functional examination.

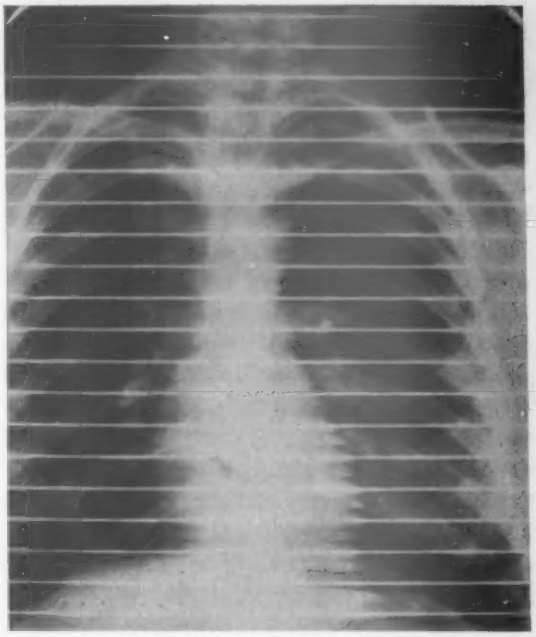

Fig. 8. Functional data of Figure 7.

When we observe a lung image we are rarely in a position to know what kind of shadow we are seeing, and only roentgen kymography can show the nature of such a shadow accurately and at any moment. All the images which I present make an analysis of the lung outline possible; even the finest ramifications register the systolic-diastolic pulse delicately. Often the images of the small vessels are more typical than those of the large trunks. The image of a vessel shadow obtained often gives the idea of a sort of accordion with its shadows bent. The circular images in the lungs, which have been incorrectly interpreted

and considered as small cavities, lose this false appearance in roentgen kymography and acquire their true significance as capricious forms of the lung outline caused by the vessels. Roentgen kymography makes it possible to analyze the different capricious shadows of the lung in such a way as to make it certain that they are only very individual types of outline, varying in each case, and completely normal.

The regions in which the vascular type of image is clearest are naturally those in which the vessels are most numerous. Such are the regions of the hila and the bases of both lungs, particularly their internal parts.

As is seen, the roentgen kymographic method gives the vascular outline of the lung with absolute accuracy and on a document which can be examined and discussed in each case.

BRONCHIAL THEORY

The normal bronchi, whether trunks or the finest ramifications under normal conditions very rarely give a roentgen image, as they are anatomical structures which can be traversed by the rays without giving an image unless there are changes in the wall, or secretion inside the lumen. If we consider how hard it is to find individuals with a perfect anatomical condition of the bronchial tree, we can see how possible it is for the lung image in some cases to be intermingled with bronchial shadows. If the image of a bronchus is to be found in the lung outline, it is best to look for it near the large vessels; the site of choice is the hila where they are largest, and under certain conditions they are found in the inner part of the base of the lung.

CONCLUSIONS

Roentgen kymography with a movable grid is an accurate method of proving the vascular theory of the lung image.

The functional analysis of the lung outline is an interesting complementary datum for the roentgen study of the normal and pathological lung.

Certain forms of lung outline with an annular appearance which in some cases simulates small cavities are clearly shown by the roentgen kymogram to be vascular in nature.

Vol. 48, No. 1

TREATMENT OF CANCER OF THE SKIN OF THE NOSE*

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CANCER of the skin of the face occurs more frequently on the nose than in any other location. The great majority of these are basal cell, a few are squamous cell and occasionally both forms are associated. The subvarieties of the basal cell group are the reticulated and adenoid types.

Several excellent therapeutic methods have been developed in the treatment of cancer of the skin of the nose, and when expertly applied, good results may be expected. No one procedure, however, will suffice for all cases, and the physician should therefore be not only skillful in the diagnosis but proficient in the various techniques employed.

GENERAL CONSIDERATIONS REGARDING TREATMENT

Since there is a wide variation in the clinical picture and histopathology of the lesions the various forms of therapy will be discussed. Small superficial lesions may be treated by monopolar electrodesiccation, and the more extensive infiltrating tumors require roentgen or radium therapy, while in the occasional resistant case, as John Hunter has said, it may be necessary to lay down the science and take up the scalpel. Prosthetic reconstruction of the nose using a latex compound may take the place of rhinoplasty in certain cases. Mild electrodesiccation gives little or no resultant scarring. Electrocoagulation, or the cutting current, is more likely to cause scarring. Electrodesiccation may be considered the treatment of choice in the very small superficial lesions. The technique consists of thoroughly desiccating the lesion and a small margin of surrounding normal skin. If there is definite infiltration the area may be curetted after electrodesiccation and the base again treated by electrodesiccation.

Roentgen and radium therapy have a direct effect on the sensitivity of the cancer cell as well as the tumor bed, blood vessels and surrounding tissues. In the superficial varieties of skin cancer of the nose, soft or low voltage roentgen radiation is obviously indicated while in the thickened, elevated and infiltrating lesions medium voltage roentgen radiation or radium therapy is required. In the past, too little attention was given the planning of an accurate dose before the treatment was started. Today by reference to dosage tables we are enabled to give the required number of skin erythema doses. If the treatment is inadequate the lesions become radioresistant while, on the other hand, overdosage will produce destruction of the normal surrounding and deeper tissues.

ROENTGEN THERAPY

Low voltage, short distance therapy, as developed by Chaoul, gives a 60 per cent absorption rate in the first centimeter of tissue, thereby sparing the surrounding healthy tissue. Dr. William Harris at Mount Sinai Hospital, New York, using the Philips apparatus, gives 3,600 r at one sitting for the small superficial lesions 1 cm. or less in diameter. The following factors are used: 45 kv., 2 ma., 2 cm. distance, 0.25 mm. Al intrinsic filtration. In the larger and more infiltrating lesions divided doses are given using 400 r daily for a total of 6,000 to 8,000 r. There is an added filtration of 1 mm. aluminum and the focal distance is 4 cm. The end-results have been most satisfactory. Experience has shown that divided doses are just as effective as a single massive dose, providing the time interval is not too long. The series of treatments should be completed within three weeks. Chaoul reports 35 cases of cancer of

* Presented at the Twenty-sixth Annual Meeting, American Radium Society, Cleveland, Ohio, June 2–3, 1941.

the nose with only one failure which was a metastasizing lesion. Eight of the 35 cases were infiltrating and 27 were not infiltrating in character. The Philips contact roentgen therapy apparatus has the same indications as the Chaoul apparatus.

For many years radiologists have used the standard low voltage roentgenologic equipment of 100 to 140 kv. in the treatment of cancer of the skin of the nose. A target-skin distance of 20 to 40 cm. is used with 1 to 3 mm. aluminum filter depending on the depth dose desired. Thick or deeply infiltrating cancers are treated with higher voltages and heavier filters in order to obtain a greater depth dose. With 100 kv., 5 ma., 1 mm. Al filtration, 2 cm. circular field, 40 cm. target-skin distance, the depth dosage is 60 per cent at 1 cm., 45 per cent at 2 cm. and 32 per cent at 3 cm.

The present day technique at the Skin and Cancer Division of the New York Post Graduate Hospital is as follows: 100 kv., 3 ma., 20 cm. distance, no filtration, 150 r per minute. In small lesions 1 cm. or less in diameter, through a field slightly larger than the growth, a single exposure of 1,500 to 2,000 r is given at one sitting. In the larger and more infiltrating lesions 300 r is given every two days for ten treatments.

MacComb has shown that at least 12½ threshold erythema doses are required to destroy skin cancers. The roentgen rays used were generated at 100 kv. and 5 ma., giving an intensity of 270 r per minute at 30 cm. target-skin distance without filter, the half-value layer of radiation being 0.03 mm. copper or 1 mm. aluminum; 350 r gave an erythema in 80 per cent of the cases in small fields varying from 0.5 to 2 cm., and for fields of 3 to 4.5 cm. 280 r was found to be sufficient. For complete regression in a lesion 0.5 cm. in diameter, 6,500 r was necessary. As much as 9,000 to 10,000 r has been administered to fields of 1 cm. or less in diameter.

Widmann states that unless the first treatment is thorough and adequate the likelihood of recurrence or failure is great. He reports 87 per cent of 156 cases of superficial lesions free of disease for two years or more in contrast to 57 per cent of 64 cases free of disease in deeply infiltrating lesions.

RADIUM THERAPY

According to Cutler, the treatment of cancer of the skin which has previously been irradiated but uncontrolled constitutes a serious and difficult phase of the treatment. Tumor cells incarcerated in dense fibrous connective tissues are much more immune to irradiation than at the initial exposure. As a rule, surgery or electrosurgery is preferable to further irradiation in the treatment of these lesions, although if the initial dosages were small a second irradiation may be undertaken with safety. Interstitial irradiation by means of removable platinum needles has proved effective in certain cases.

It is difficult to say whether radium or roentgen therapy is preferable in the treatment of skin cancer of the nose. The technique of radium therapy also varies according to the type and extent of the growth. Small superficial lesions may be easily treated by means of the beta-ray plaque. It is estimated that 75 per cent of the beta rays is absorbed by the first 2 mm. of tissue, and 15 per cent is absorbed in the next 2 mm. of tissue. Radium needles are also effective in the more infiltrating lesions. If 0.2 mm. of gold or platinum filter is used the emitted radiation is composed of 22 per cent beta and 78 per cent gamma rays; the relative amounts of radiation with 0.3 mm. of gold or platinum filter is 9 per cent beta and 91 per cent gamma rays. The equivalent of 0.5 mm. platinum filter gives 100 per cent gamma radiation. It has been determined that a point source of 1 mg. of radium filtered with 0.5 mm. of platinum gives a dose of 8.3 r_γ in one hour at a distance of 1 cm.; 1,000 r_γ given in two hours or less corresponds to a threshold erythema dose. A small needle 10 mm. long placed in the center of a spherical mass 2 cm. long will deliver to the periphery of the lesion 1,000 r_γ after 135 mg-hr. of radiation. The amount of radiation given a few years ago

was more or less empirical; today the quantities of radiation necessary to deliver specified minimum doses in various tissue volumes is well known. Radium radiation has the advantage of being absorbed in the superficial and subcutaneous tissues; for example, radium over an area of 2 sq. cm. with 0.5 mm. platinum filtration at 1 cm. distance giving 100 per cent on the surface has a depth dose of 44 per cent at 5 mm. and 28 per cent at 1 cm. Gold radon implants may be used instead of radium needles for interstitial therapy. The implants should be evenly distributed and the dosage carefully calculated. A large amount of gamma radiation applied to lesions at the root of the nose and near the lids will produce changes in the lens; however, unless the dosage is excessive the amount of radiation reaching the eyeball is usually not harmful. We have found gold radon implants effective at the root of the nose when the lesion has extended to the inner canthus of the eye and into the orbit. The intensity of the interstitial irradiation is much greater in the depths of the tumor than on the surface. Irradiation by means of surface application of radium or by roentgen therapy is much greater on the surface than in the deeper portions of the growth.

PROSTHETIC RECONSTRUCTION AND PLASTIC SURGERY

During the past four decades there has been a steady refinement in the technique of producing artificial noses, as well as in the materials used. The use of vulcanite has given way to a liquid rubber preparation of latex. This material is converted into a solid, elastic state on exposure to warm dry air or in a dry plaster of paris mold. According to Bulbulian restoration by prosthetic methods is useful in patients of advanced age, in those requiring a temporary restoration before rhinoplasty is advisable, and in patients with defects too extensive to repair, or who do not wish to submit to further surgery.

Dr. Clarence R. Straatsma, in a discussion of some problems of nasal plastic surgery, states:

> The skin of the lower half of the nose differs from any other skin, in that it is extremely rich in sebaceous glands and is somewhat rugged in appearance, which makes it very difficult to match both in texture and color with unexposed skin when replacing losses in this area. Large skin losses are usually replaced by using a pedicled forehead flap, but such flaps are not practical for small tip losses and in many instances are too thick to produce the best result.
>
> Free grafts to the nasal tip were formerly rather hazardous because of the difficulty in maintaining a fixed and proper pressure over the graft; however, this has been overcome by using the suture pressure method. To use this method, each suture that is used to hold the graft in place is left about three inches long, and when it is completely fixed these sutures are tied over gauze to produce pressure. There may be some cupping of the grafted area but this usually levels itself off after a period of a few weeks. Experience has shown that the grafts take more successfully when they are kept moist with saturated boric or normal saline solution than when left dry. The gauze is moistened twice daily with the solution, at either room or body temperature but never hot.
>
> A good source of free grafts for small skin losses about the nasal tip is the postauricular area because this has the best color match. When removing small pieces of skin, the area can be closed after undermining; however, when large pieces of skin are removed it is necessary to repair the postauricular defect with a second graft from elsewhere on the body, usually from the inner aspect of the thigh, in order to avoid distortion of the ear. Another excellent source of free full-thickness skin grafts for nasal tip repair is the upper eyelid, where as much as half of the skin may be removed and the incision sutured without any disturbance of function and very little, if any, visible deformity.
>
> For columellar losses, it is frequently necessary to use a small pedicle graft, usually tubed, because in most instances it is necessary to replace subcutaneous tissue as well as skin.
>
> Cartilage and bone are the best sources of material for building up large losses of the nasal ridge. Pickled cartilage is now being used successfully and this considerably simplifies the repair of such cases. Pickled cartilage often is

FIG. 1. Case I. *A*, scar tissue and ulceration in a previously treated hemangioma of the face. *B*, excision of scar tissue and pedicle flap in situ. *C*, end-result showing plastic repair.

easy to obtain and is not so apt to curl after it is placed in the nose. A combination of grafts must be used to repair a given condition.

CASE REPORTS

The following case history is interesting from both the radiation and surgical standpoints:

CASE I. C. H., female, aged sixteen when first seen by Dr. Straatsma on June 24, 1927. She had received numerous radium treatments, between the ages of five and ten, for an extensive angiomatous birthmark on the left side of the face. Two chronic ulcers each the size of a half dollar had developed in the scar tissue a few years after the radium treatments had been given. Biopsy from the edge of the ulcer on the nose revealed squamous cell carcinoma Grade 3. The total area of scar tissue measured 12 square inches. At the junction of the nose and cheek the ulceration extended to the periosteum. A considerable portion of the left ala was destroyed, the left side of the upper lip was drawn upwards and an ectropion had developed on the lower lid. A series of plastic procedures were necessary to complete the repair. There has been no evidence of recurrence of the carcinoma in over ten years that the patient has been under observation (Fig. 1, *A*, *B* and *C*).

CASE II. E. F. W., a railroad tower switch operator, aged sixty-one years in 1941, gave a history of a small scaly lesion appearing on the left side of his nose in the fall of 1917. "A scab would form about every four days, a little itching would be felt and the scab would brush off easily. There was no soreness and the condition

remained about the same for one and one-half years." The patient was inadequately treated by radium, and when we saw him first in 1932 there was an extensive recurrence involving the tip and side of the nose. Divided doses of radium were administered and the condition healed again. In 1939, however, a small crater ulcer appeared at the upper edge of the scar and there was a nodular painful infiltration in the tip of the nose and nasal septum. The lesion was now radioresistant and the patient was advised to submit to surgery. On December 11, 1939, under local anesthesia the tip of the nose and septum were removed by the scalpel. The base of the wound as well as the ulcer at the junction of the nose and cheek was treated by electrocoagulation. Six weeks after the operation a latex prosthesis was designed and applied by Dr. George Ackerman. There has been no recurrence. The patient has chosen to have a plastic reconstruction of the nose, and is at present time under a series of operations by Dr. Gustave Aufricht (Fig. 2, *A* and *B*).

Around them there are dilated vessels and an infiltrate of small round cells, plasma cells and some connective tissue cells. The epidermis shows an irregular acanthosis, in part hypergranulosis and hyperkeratosis. The masses in the cutis shows anaplasia, whorl and pearl formation, and they are for the greater part not lined by basal cells. At one side of the section the cell proliferations have a different character. The cell bodies are not so large, the nuclei are of considerable size, irregular, deeply stained. Microscopic diagnosis: Prickle cell epithelioma becoming embryonic."

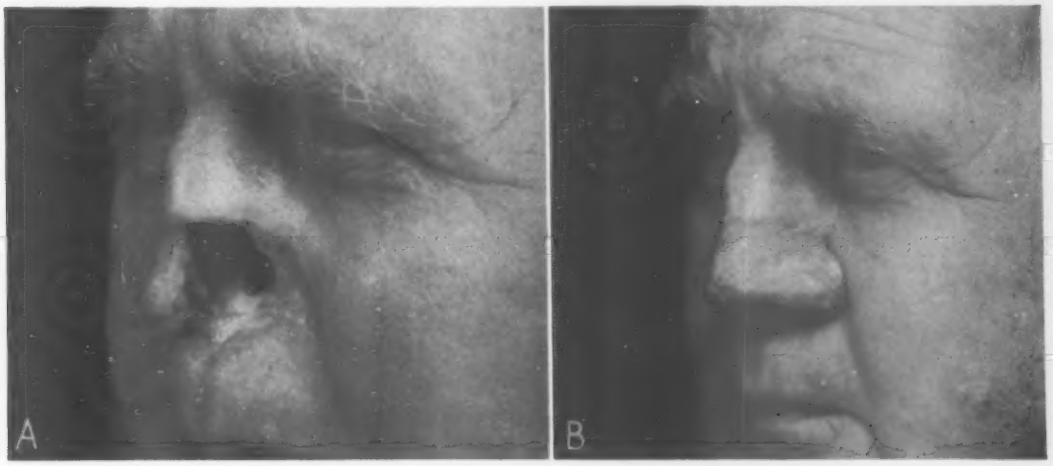

Fig. 2. Case II. *A*, cancer of the nose healed after surgery and electrocoagulation. *B*, prosthetic reconstruction using latex compound.

Case III. F. B., aged sixty-four, reported to the New York Skin and Cancer Division of the New York Post Graduate Hospital early in January, 1938, with a hard infiltrated and ulcerated lesion 1 cm. in diameter over the left side of the nose. The condition began about one year previously as a small lesion which gradually grew larger. A biopsy was taken and the microscopic findings were as follows: "Extending from the upper cutis down to the bottom of the section there are large masses of cells.

The treatment consisted of ten applications of low voltage roentgen therapy using the following factors: 60 kv., 5 ma., 12.5 cm. distance, 2 mm. Al filtration, 2 cm. field, 6 min. exposure, giving 480 r per treatment.

When last observed on March 31, 1941, there was no sign of recurrence and the cosmetic result was excellent (Fig. 3, *A* and *B*).

Case IV. J. D., male, aged seventy-one, was first treated in the Tumor Clinic of the New York Post Graduate Hospital on March 17, 1922. Examination revealed a large non-painful papillary ulcerated growth involving the tip and alae of the nose, 4 cm. long, 2 cm. wide and 1 cm. thick. Histopathological studies showed squamous cell carcinoma. Four divided doses of interstitial radiation by means of platinum radium needles were given in a period of two months. In the late summer and fall a beta-ray plaque was used to further improve the condition of the nose.

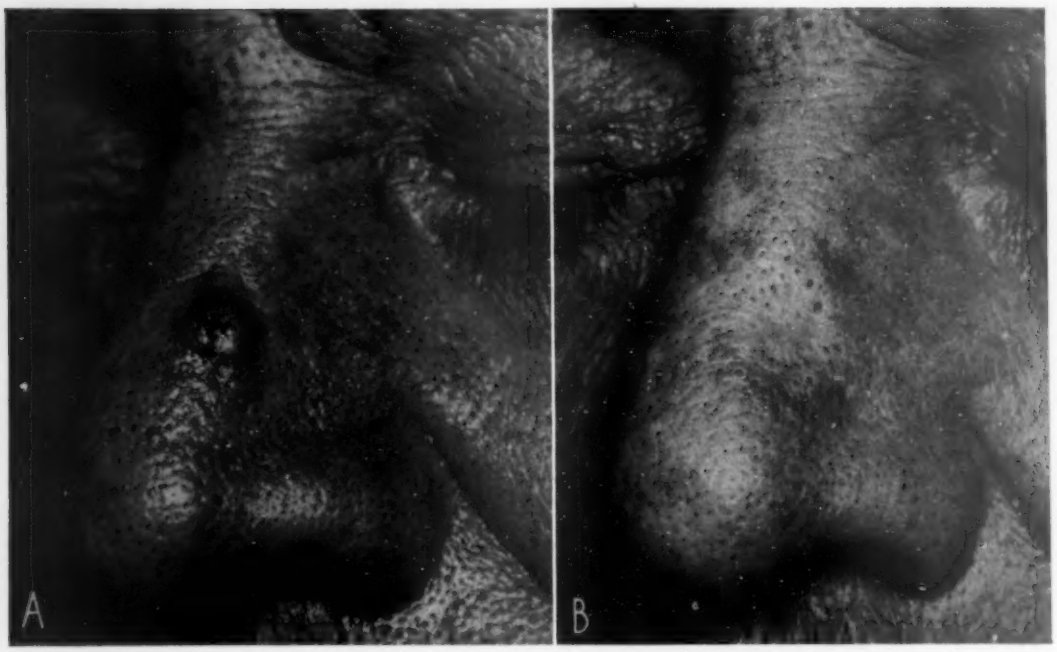

FIG. 3. Case III. *A*, early squamous cell carcinoma of the nose. (Courtesy Skin and Cancer Division, New York Post Graduate Hospital.) *B*, lesion healed after divided doses of low voltage roentgen radiation.

1922	Amt. Radium	No. Needles	Filter	Time	Dosage mg-hr.
March 17	82.5	10	0.2 mm. Pt	2 hr.	165
April 9	30.0	4	0.2 mm. Pt	2 hr.	60
April 25	20.0	4	0.2 mm. Pt	3 hr.	60
May 19	27.7	4	0.2 mm. Pt	2 hr.	55
August 18	25.0	Plaque	None	1½ hr.	37.5 (3 spaces)
November 17	25.0	Plaque	None	1 hr.	25 (2 spaces)

There was no gross destruction of the nasal cartilage and the final end-result was excellent; a smooth, soft scar replaced the original lesion (Fig. 4, *A* and *B*).

CASE V. J. D., aged sixty-five, was treated by us on May 10, 1936, for a recurrent carcinoma of the root of the nose and extending to the inner canthus of the left eye. Two operations had been performed during the preceding five years. The mass measured 2.5 cm. in length, 2 cm. in width and 1 cm. in thickness.

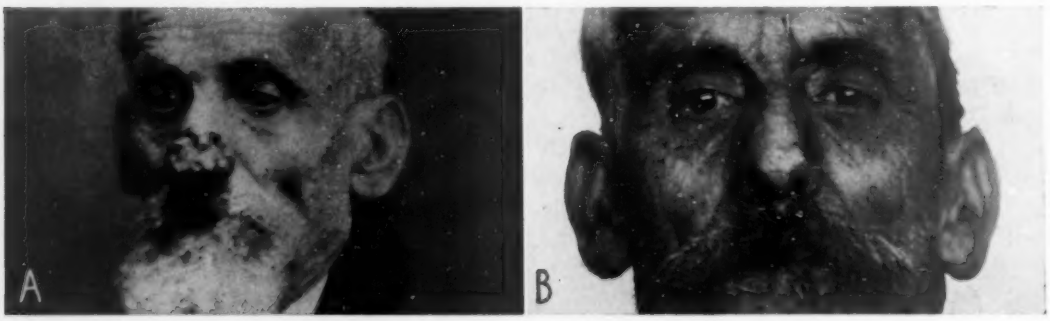

FIG. 4. Case IV. *A*, large papillary squamous cell carcinoma of the external nose treated by radium. *B*, end-result showing fibrous tissue replacing growth.

The center of the lesion was ulcerated, the edges raised and pearly. The clinical diagnosis of basal cell carcinoma was confirmed by biopsy. Ten gold radon implants of 1.5 mc. each were inserted into the base and edges of the growth, and after three weeks an additional 9 mc. in six gold radon implants were imbedded into the growth. Approximately 10 threshold erythema doses were given in each application. A rather severe inflammatory reaction was produced, but two months after the last treatment healing was complete and there has been no evidence of recurrence during the past five years.

SUMMARY

1. Precancerous lesions and early cancer of the skin of the nose may be properly destroyed by electrodesiccation.

2. Every case of skin cancer of the nose should be thoroughly treated in order to prevent recurrence of the growth.

3. The technique of radium and roentgen therapy varies with the type, location and extent of the lesion. Equally good results have been obtained by single massive doses of radiation, or by divided doses, providing the total dosage has been adequate and given within a period of three to five weeks.

4. Prosthetic reconstruction and plastic surgery are essential to the restoration of defects following the treatment of the advanced cases.

5. In our series of 146 private patients with cancer of the nose the end-results have been satisfactory in all but twelve advanced cases.*

* For discussion see page 74.

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TREATMENT OF EPITHELIOMA OF THE SKIN OF THE EAR*

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THIS report is made because we are not in agreement with many published reports that epithelioma of the ear is uncommon, that it is, in general, squamous cell in type and that because of the presence of cartilage, the treatment is unusually difficult. We believe that uncomplicated cases of epithelioma of the ear are just as amenable to treatment, by approved methods, as similar cases on any other area of the skin. However, it is true, as Pfahler and Vastine[10] have pointed out, that recurrent epithelioma in the region of the ear may be extremely difficult to cure permanently. Failures usually have resulted from faulty or insufficient early treatment. Modern techniques of employing radiation have resulted in the cure of many complicated cases which formerly would have been considered hopeless.

Epithelioma of the skin of the ear is frequently encountered by dermatologists and radiologists, but, from published reports, is seldom seen by otologists. While involvement of the auricle is common, it must be sharply differentiated from primary epithelioma of the external auditory canal, which is extremely rare. Robinson[11] reports that epithelioma of the ear occurred in one out of 4,000 cases of ear disease at the Manhattan Eye, Ear and Throat Hospital. Fraser[4] states that 13 cases, or 0.197 per cent, of involvement of the external auditory meatus occurred at the Royal Infirmary in Edinburgh, out of 6,605 external ear conditions. Scott and Colledge[12] recently analyzed 70 cases of carcinoma of the ear, exclusive of the auricle, reported in the literature over a period of thirty-one years. Bezold[1] saw only 3 cases of epithelioma of the external auditory canal out of 20,000 otological patients over a period of twenty-four years. Broders[2] reviewed 63 cases of epithelioma of the ear and found that 84.12 per cent were on the auricle, 14.28 per cent in the external auditory meatus and 1.58 per cent in the middle ear. The involvement of the external auditory canal is unusually high in this series. Recently Mitchell[8] was able to report only 3 cases of epithelioma of the external auditory canal from the records of the Cleveland City and Lakeside Hospitals in Cleveland.

This study is based upon the treatment of 130 cases of epithelioma involving the skin of the ear and represents an incidence of 5.5 per cent of a total of 2,364 cases of epithelioma of the skin treated over a period of twenty-five years.

ETIOLOGICAL FACTORS

The age incidence corresponds to that of epithelioma of the skin in general. The average age of the patients was 64.3 years.

There were 96 cases in men and 34 in women. Outside occupations in the cases of the majority of the men account for this difference, as is shown by the presence of keratoses on the ears in 81 cases. The next most important etiological factor was trauma from eyeglass temples seen in 30 cases. In this connection, it is found that in some persons, a sensitization to nickel results in a chronic dermatitis. In still others, an irritation is produced through the corrosive action of the skin secretions which roughens the metal. The present custom of protecting the ear by placing a rubber tube pad over the metal shaft is a splendid preventive measure. This, in addition to the use of plastic temples on eyeglasses, should practically eliminate this causative factor.

Other factors possibly playing a rôle in-

* From the Department of Dermatology and Syphilology of the School of Medicine of Western Reserve University and of the University Hospitals. Read at the Twenty-sixth Annual Meeting, American Radium Society, Cleveland, Ohio, June 2–3, 1941.

clude frostbite, cutaneous horns and tar keratoses, each seen in 3 cases. Psoriasis, lupus vulgaris, eczema, xeroderma pigmentosum and trauma resulting from combs, burns and razor cuts were also encountered. Flat, black, non-hairy nevi resulted in 2 cases of melano-epithelioma. In 44, or 34 per cent, there were or had been epitheliomas on other areas of the skin. Epithelioma on the ear as in other locations is nearly always preceded by a precancerous lesion.

LOCATION OF LESIONS

In regard to location of lesions, the posterior auricular fold was involved in 39 cases, in 6 of which it occurred by extension from epithelioma of the scalp. The helix was primarily affected in 41 cases and secondarily by extension in 6 additional ones. The tragus was primarily involved in 3 instances and secondarily in 11 cases from extension of lesions in front of the ear. Both the tragus and lobe were affected in 3 cases. Primary involvement of the external auditory canal occurred in only 1 instance, but extension into the canal of lesions on the outside was found 6 times. There were 4 cases in the concha alone and 5 on the anthelix. The lobe was the site in 4 cases and in 7 others by extension from the surrounding skin.

In 86, or 66.15 per cent, of the cases, the lesions were present on the helix or posterior auricular fold. This is not surprising when it is realized that keratoses are more common on the helix. Moreover, in the posterior auricular fold, there is frequently encountered the effect of irritation of eyeglass temples.

In 35, or 27 per cent, of the 130 cases the perichondrium had been clinically invaded.

TYPES OF LESIONS

Biopsies were performed in 71 out of 130 cases. Of these, 41, or 57.7 per cent, were squamous cell; 24, or 33.8 per cent, basal cell; and 2, or 2.8 per cent, basosquamous epitheliomas. In addition, the list includes 1 cylindroma, 2 melano-epitheliomas and 1 sarcoma of Kaposi.

In 20 of these biopsied cases in which the malignant growth was primary on the helix, 18, or 90 per cent, were squamous cell and 2, or 10 per cent, basal cell. In the posterior auricular fold, 7 were squamous and 3 basal cell, while in 4 additional ones involved by extension from the scalp, basal cell tumors were found. From further analysis of the biopsy material, it is found that

Fig. 1. Morphea-like basal cell epithelioma (epithelioma basocellulare superficiale cicatrisans) involving eyebrow, temple, scalp, and showing invasion of the ear. Treated by superficial electrodesiccation and curettage. Has remained well over five years.

in 19, or 26.6 per cent, basal cell epitheliomas occurred in lesions which primarily involved the ear. This is at variance with the usual statement in the literature that epithelioma of the ear is nearly always squamous cell in type. While this variety is the rule in about 3 out of 4 cases, nevertheless basal cell lesions may develop on any area of the ear. In a series of 134 cases reported by Pfahler and Vastine,[10] 36 per cent were basal cell, 36 per cent squamous cell, and 28 per cent mixed types. The higher incidence of basal cell lesions may be accounted for because of a larger percentage of lesions arising on the skin surround-

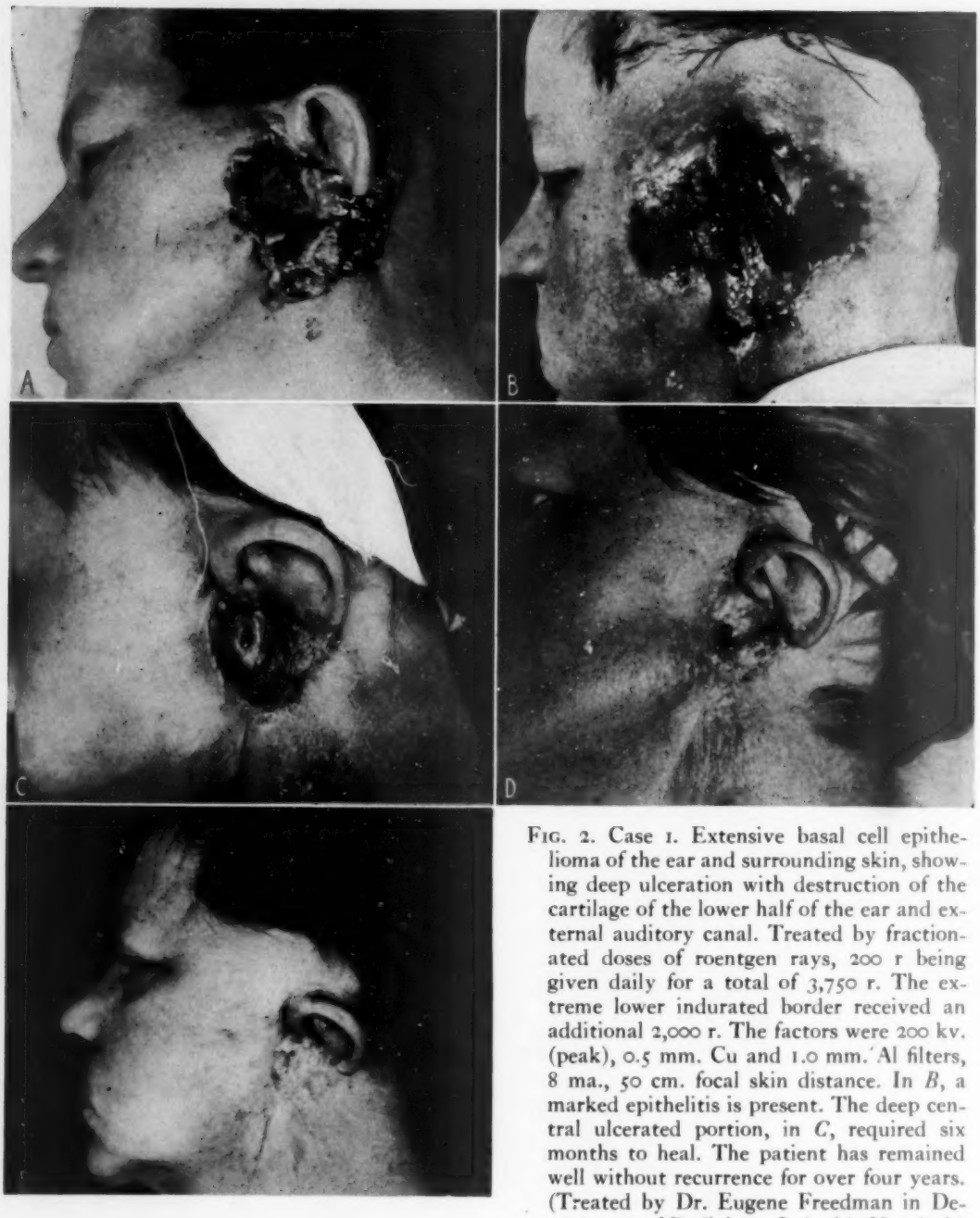

FIG. 2. Case 1. Extensive basal cell epithelioma of the ear and surrounding skin, showing deep ulceration with destruction of the cartilage of the lower half of the ear and external auditory canal. Treated by fractionated doses of roentgen rays, 200 r being given daily for a total of 3,750 r. The extreme lower indurated border received an additional 2,000 r. The factors were 200 kv. (peak), 0.5 mm. Cu and 1.0 mm. Al filters, 8 ma., 50 cm. focal skin distance. In *B*, a marked epithelitis is present. The deep central ulcerated portion, in *C*, required six months to heal. The patient has remained well without recurrence for over four years. (Treated by Dr. Eugene Freedman in Department of Radiology, Lakeside Hospital.)

ing the ear. Also the high percentage of mixed types could perhaps be explained on the relatively large number of recurrent epitheliomas in which, according to our experience, mixed types are most likely. A morphea-like basal cell epithelioma (epithelioma basocellulare superficiale cicatrisans) is sometimes seen in the concha. It may spread and even involve the canal. It is superficial, has a fine pearly, wax-like border, and, in some cases, may become quite extensive. It sometimes spreads to the ear

from the surrounding skin (Fig. 1). There is a tendency to self-healing in the center. leaving a characteristic morphea-like scar.

TREATMENT

The skin covering the ear is thin and closely adherent to the underlying cartilage. On the concha side of the auricle there is no subcutaneous tissue between the skin and cartilage. In most cases the cartilage is neither easily nor at an early stage involved, yet once invaded, this greatly complicates the treatment.

The treatment of epithelioma of the ear cannot be standarized. Each case must be considered individually. The statement is frequently made that these cases are best treated by electrosurgical measures because the cartilage recovers poorly or not at all following the large doses of radiation necessary to destroy the malignant growth. We believe this idea is erroneous for it has been possible, by radiation therapy, to get the same satisfactory results in lesions on the ear as in similar lesions on other areas of the skin. While healing may be somewhat slower, an excellent cosmetic result is generally obtained.

It is certainly true that many cases formerly considered hopeless are now successfully treated with the modern technique of employing radium and roentgen rays. This is especially true in certain instances where recurrences have occurred following insufficient irradiation or from inadequate surgical or other procedures. The following cases are examples:

Case I. (Fig. 2) A woman, aged fifty-four, seen on January 2, 1937, in 1933 noticed a small papule behind the left ear, which was subsequently traumatized by her comb. She used home remedies, including poultices, without benefit. The lesion continued to enlarge and in August, 1935, she developed a left-sided facial paralysis. Beginning in April, 1936, she was treated by a physician who used the "electric needle," sun lamp treatments and diets.

The lesion was roughly circular, measuring about 10 by 12 cm. The center was deeply ulcerated and the tragus, external auditory canal and the lower half of the auricle was destroyed. The preauricular and postauricular lymph nodes had been invaded by the overlying growth. The borders were indurated and presented a rolled appearance. The entire lesion was firmly adherent to the underlying tissues. A biopsy showed basal cell epithelioma. Treatment was by roentgen rays, using a modified Coutard technique.

Technical Factors. The lesion was divided into an upper and a lower portion for purposes of treatment. The portal was 9 by 11 cm. for both fields. The factors were 200 kv., 0.5 mm. copper and 1 mm. aluminum filters, 8 ma., 50 cm. focal skin distance and 200 r per treatment for a total of 3,375 r to each field. Treatments were given daily, except Sunday. To the extreme lower border where the infiltration was greatest, an additional 2,000 r was administered through a portal 1.5 by 3 cm. The factors were 100 kv., 2 mm. aluminum filter, 5 ma., 25 cm. focal skin distance, 200 r daily.

Removal of the uninvolved upper portion of the auricle before treatment was refused by the patient and it was impossible to protect it in order to satisfactorily irradiate the lesion. As a result, this area also participated in the marked epithelitis which developed. In spite of the presence of cartilage, healing was uneventful. However, the deep, ulcerated and infected central portion of the lesion, approximately 4 cm. in diameter, required nearly six months to heal completely. The patient has remained well, without recurrence, for over four years, to date. (This case was treated by Dr. Eugene Freedman in the Department of Radiology of Lakeside Hospital.)

Case II. (Fig. 3) Male, farmer, aged forty-eight. This patient developed a growth in front of the left ear in 1929. A recurrence developed following treatment by the "electric needle" and a "cancer paste." When first seen in April, 1930, there was present a large infiltrating, ulcerating, squamous cell epithelioma involving the tragus, cartilage and the area in front of and below the ear and infiltrating the lower portion of the posterior auricular fold. Treatment was by interstitial irradiation with heavily filtered low intensity radium needles. The dosage was 3,034 mg-hr. in seven days. The patient has remained well over ten years.

The concept that radioresistance always contraindicates the use of further irradia-

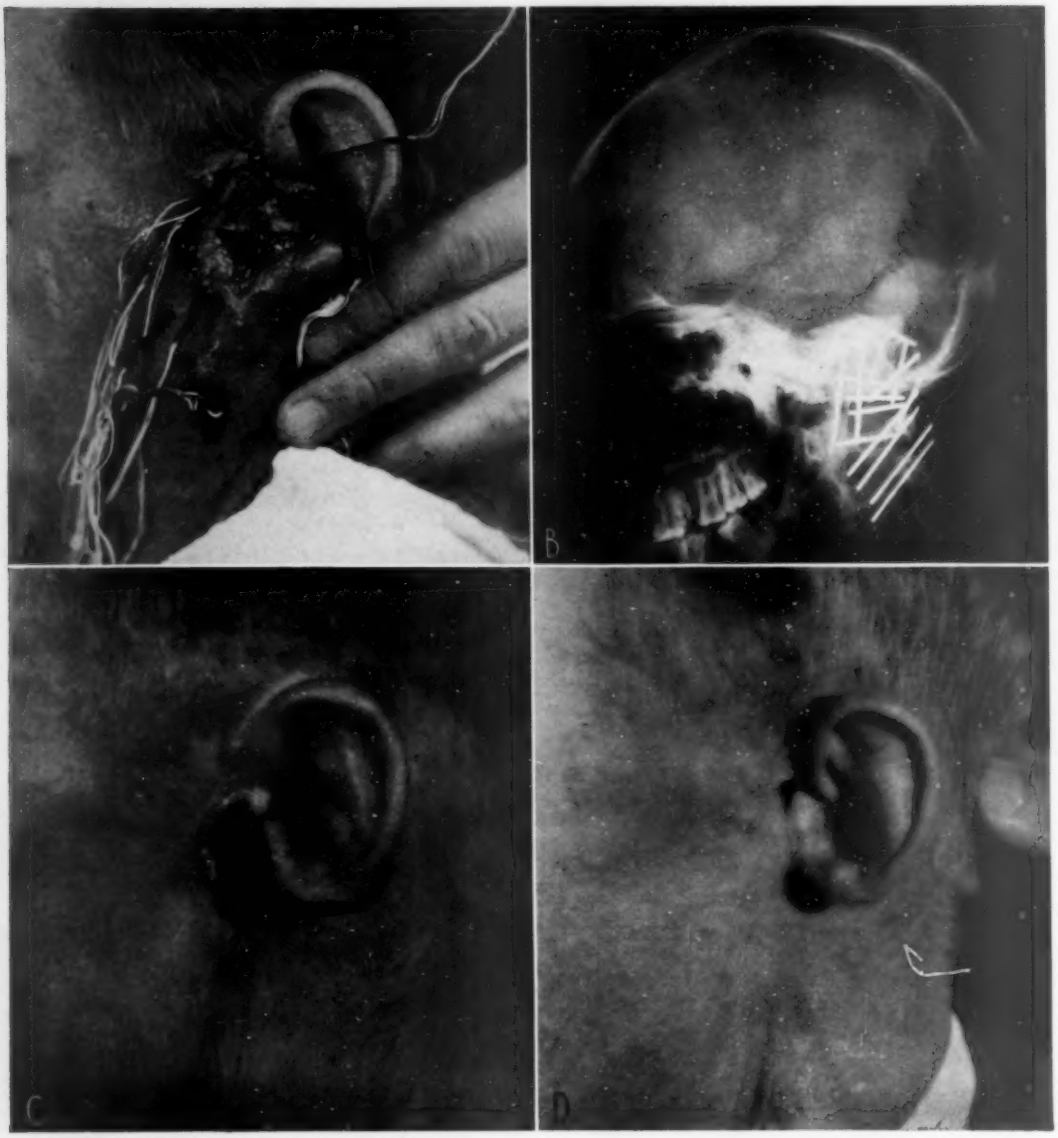

Fig. 3. Case 11. Squamous cell epithelioma involving cartilage. Treated in April, 1930, by interstitial irradiation with low intensity, heavily filtered radium needles. Dosage, 3,034 mg-hr. in seven days. The central ulcerated portion required four months to heal. *C* shows the slowly healing portion at the end of eight weeks. The patient has remained well over ten years.

tion has been changed. Many of these cases simply received inadequate dosage. On this point, it should also be stated that considerable experience and sound judgment are necessary in deciding whether further irradiation should be used. As nearly as possible, the exact amount of previous irradiation should be known. If irradiation necrosis is present, additional irradiation may be disastrous. In some cases of this kind, cosmetic results are a secondary consideration and extensive excision may be advisable.

Formerly, it was our custom to rely to a large extent upon the use of electrocoagulation, electrodesiccation, the cautery and curettage. The results, as a whole, were good, but equally satisfactory and better cosmetic results are possible by irradiation, and in recent years, reliance has been placed

more and more on its use. We agree with Lehmann[5] who states, "The advantages of treatment by radiation justify its use in nearly every case, unless indications point definitely to futility."

In 27 cases, divided doses of roentgen rays were used. The technique was as follows: 100 kv. (peak), 5 ma., 25 cm. distance, without filter. The dosage varied from 3,200 to 6,000 r, depending upon the size of the lesion and the pathological diagnosis. A dose of 800 r is given every other day. When the larger doses were used, 1,000 r was administered every other day. In a few extensive, deeply infiltrating or recurrent lesions, a filter of 3 mm. of aluminum and 140 kv. (peak) was substituted and a total similar divided dosage was given. Even higher voltage, using 220 kv. (peak) with a filter of 0.5 mm. Cu and from 1 to 4 mm. Al, at 50 cm. distance, in divided doses, has also been employed.

Interstitial gamma irradiation with low intensity, heavily filtered radium needles was used in 10 cases. This method was employed in the more extensive, infiltrating lesions or in instances of recurrence, where previous therapy had been insufficient. The needles containing 1, 2, or 3 mg. of radium element are so constructed that they contain 1 mg. of radium for each 15 mm. of active length. Thus there is a continuous radiating focus of equal strength per running centimeter. The diameter of each needle is 1.65 mm., with a wall thickness of 0.5 mm. of platinum, sufficient to filter out nearly all beta rays. Each is equipped with an iridium trocar point and the other end is closed by an eyed stopper to which sutures are attached for holding them in place and facilitating their removal. The technical factors in their use have been described in detail in a previous paper.[3] In radioresistant lesions and in cases where considerable infection is present, gamma rays are often the method of choice. Merritt and Rathbone[7] have successfully treated similar lesions by high voltage roentgen rays using 220 kv. (peak), 2 mm. copper and 1 mm. aluminum filter, giving from 4,500 to 6,000 r in fractional doses over a period of about three weeks. As Lehmann[5] and others have pointed out, the effect of beta rays on cartilage is similar to infection. These rays are contraindicated in all but very superficial lesions.

The treatment of lesions involving bone and cartilage or recurrence following previous irradiation always presents a difficult and at times an insoluble problem. Taussig[14] states, "It has been found that in instances in which cartilage or bone is involved, irradiation in effective dosage is apt to produce painful and intractable reactions." Also Broders[13] in 1932 stated, "I have never seen a case in which the periosteum or the perichondrium was involved and irradiation alone cleared up the trouble." Taking the opposite view, Ullmann[15] believes that involvement of the cartilage does not necessarily contraindicate the use of irradiation and he has successfully treated such cases many times. Our own experience has shown that involved cartilage does respond favorably to gamma irradiation. If cartilage is not involved, irradiation methods, either alone or combined with electrosurgical procedures, are adequate in the great majority of cases.

For small lesions, the expert use of electrodesiccation and curettage or of the electrocautery and curettage is satisfactory and good cosmetic results are obtained. Because of the underlying cartilage, stretching the skin enables one to better determine the exact extent of the tumor invasion. These methods alone or combined with surface irradiation were used in 66 patients.

Quite recently we have been using the unfiltered glass radon bulb, as described by Pack[6], in the treatment of keratoses and of the early superficial epitheliomas including those on the skin of the ear. The amount of radon in the bulb has ranged from 100 to 200 millicuries. For keratoses, the exposure varies from 300 to 600 millicurie-minutes of contact, depending on the size of the lesion and the amount of radon used. In epitheliomas, the exposure is from 800 to 1,500 mc-min. The effect, on the whole, of this form of superficial beta irradiation has been very good. This is true particularly in the

treatment of keratoses. The effect on the cartilage is minimal and the tendency to recurrence of keratoses is less than when the cautery and curettage are used. Beta irradiation in superficial lesions is ideal, for a deep effect of the rays is neither necessary nor desirable. MacKee[14] states that, "Beta rays appear to be more efficacious than gamma rays or X-rays when the lesion is very superficial." We agree with Lehmann[5] that if the lesion is prickle cell in type or infection is present, the larger doses required will result in radiation necrosis if beta rays are employed.

Primary involvement of the external auditory canal is always dangerous and difficult to eradicate. The single case in our series was a woman, aged fifty-two. The lesion was approximately 1.5 cm. in diameter, located in the floor of the canal and was squamous cell in type. She had had extreme pain for nearly four months before treatment was given. Treatment by the surface application of radium and later, following a recurrence, by electrocautery and curettage, did not prevent invasion of the middle ear and temporal bone, resulting in death from meningitis.

We now believe that epithelioma of the ear canal is best treated by radical surgical methods or by thorough destruction with the electrocautery or electrocoagulation and in some instances by combining this with radiation therapy.

There were 2 cases of melano-epithelioma. One was a girl, aged twelve, who had a flat slate-colored mole, 1 cm. in diameter, on the posterior surface of the upper part of the auricle, which had begun to enlarge, following trauma from her comb, about three months previously. Histologic examination, confirmed by Dr. Allan Graham, showed melano-epithelioma. The lesion and surrounding area of skin, for a distance of 1 cm., was destroyed by the actual cautery. There has been no recurrence in over fifteen years. In the other case, a man, aged fifty, had a melano-epithelioma on the lobe of the ear, with metastasis to the cervical lymph nodes. Treatment was futile. Melano-epitheliomas should always be treated by thorough destruction or by radical excision. The cosmetic result is of secondary importance.

RECURRENCES

In this series there were 44 patients who had suffered recurrences following previous treatment. Various ointments and poultices had been applied in 15, cancer pastes, caustics or the "electric needle" in 10, surgical excision had failed in 8, and roentgen or radium therapy had been employed in 9. In 4 of this group death resulted from extensive involvement, further treatment being futile.

There were 10 cases showing recurrences following treatment given by us. In 4 the lesions were in the posterior auricular fold, in 3 the lower portion of the ear together with the cheek or neck, in 1 in the ear canal, in 1 on the tragus and in 1 on the helix. Most of these were in extensive complicated cases.

Recurrence usually results from insufficient treatment and often seriously complicates further therapy because of metastasis or of the presence of cancer cells in scar tissue.

METASTASIS

As regards metastasis, we agree with Morrow and Taussig[9] that squamous cell epithelioma of the ear is usually less malignant, is slower in growth and involvement of the neighboring lymph nodes is later than the same type of lesion in other locations.

In this series of 130 cases, there were 7 which developed metastasis. In 1, with involvement of the postauricular node from a lesion of the helix, treatment was given by interstitial irradiation with low intensity radium needles, the dosage being 840 mg-hr. This patient has remained well over eight years.

In 2 other cases, direct extension from infiltrating overlying cancer involved the preauricular node. Treatment by interstitial radium needles effected a cure in both instances.

In 5 cases, the cervical nodes were involved. In 1, surgical dissection was fol-

lowed by heavily filtered roentgen therapy. In the remaining 4 cases, the disease was inoperable. One of these was a case of melano-epithelioma. All 5 cases died as a result of cancer. In Broders'[2] series of 63 cases, 6 developed cervical node involvement and all died of the disease following surgical dissection.

RESULTS

In this series of 130 cases, 107 have been followed for more than one year. Of these, 37, or 34.6 per cent, remained cured more than five years; 24, or 22.4 per cent, from three to five years, and 46, or 43 per cent, from one to three years.

In this group of 107 cases, 9 are known to have died of metastasis or of uncontrolled spread of the growth. There were also 4 that died of cancer in less than one year. This leaves 94, or 87.9 per cent, of possible cures of from one to five years or more.

We believe this compares favorably with the results obtainable in the treatment of epithelioma on other areas of the skin.

SUMMARY

1. It is shown that while unusually difficult complications may arise in the treatment of epithelioma of the ear, yet such cases are usually the fault of insufficient or faulty treatment. Correctly diagnosed at an early stage they present no greater problem in treatment than similar lesions on other areas of the skin. It may be added, however, that, as a group, once complications set in they do require unusually careful consideration, necessitating sound judgment and experience in their care.

2. Of the biopsied cases that primarily involved the ear, 26.6 per cent were basal cell in type. This is a somewhat higher percentage than is often reported.

3. The presence of cartilage in uncomplicated cases does not contraindicate the use of properly selected radiation therapy.

4. Complications requiring skillful handling are present in extensive, deep, ulcerated and infected lesions with the cartilage invaded or destroyed. Heavily filtered radiation or electrosurgery may be indicated. Properly treated by the newer methods, many cases formerly considered hopeless are now cured.

5. Early epitheliomas can be satisfactorily handled by local destruction with electrodesiccation and the electrocautery or by radiation therapy. It is important that they be thoroughly treated.

6. There were 87.9 per cent possible cures of from one to five years or more in the cases followed for more than one year.

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DISCUSSION ON PAPERS BY DRS. ROBINSON AND HARRIS, AND DRIVER AND COLE

DR. EVERETT S. LAIN, Oklahoma City. I believe that most of you will join me in expressing your commendation and appreciation of these authors' presentations, two of the most valuable contributions during the past seven years to the subject of radiation treatment of cancers of the face.

We also will agree with their conscientious analyses and the progress which they seem to have made in their technique and results.

In a discussion of a presentation of Lehmann in 1934 of cancer of the ear, in which the matter of treatment, particularly of cartilaginous structures, came up, Dr. Cole expressed a preference for electrosurgery over irradiation. My associates and I have also undergone somewhat of a change of opinion and technique in the treatment of such structures. Since we have been using more gamma than beta radiation our results have proved much more satisfactory than previously. The cosmetic effect in particular is better, and I know that our percentage of cures is higher.

I want to give credit to Dr. Charles L. Martin who impressed me with the increased value of interstitial irradiation with platinum needles in his address before this Society about eight years ago.

It is surprising how well a cartilage will stand gamma radiation from interstitial platinum needles. However, we all meet the various types of malignant lesions which demand the exercise of our best judgment. I don't think any expert radiologist is yet ready to offer a standardized treatment of malignant growths involving the ears and nose. In such areas there are so many complications that we are particularly put to our best thought when we find that the cartilage is already destroyed with secondary infection. However, in such cases, irradiation is rarely contraindicated. In fact, I believe it is possible to get good results in many of these cases by irradiation alone without resorting to electrosurgery, which was our former custom.

May I call attention to one therapeutic agent which we have used for the past two years in cases complicated by secondary infection. It has been our custom first to endeavor to reduce inflammation, edema and infection by local treatment before irradiation is used. This consists of the application of a supersaturated solution of powdered sulfanilamide in glycerine. Glycerine will dissolve approximately 1 dram to the ounce. Make the application in form of wet gauze packs for twenty-four to forty-eight hours and you will note a marked depletion of inflammatory tissue, reduction of edema and control of secondary infection. Then the malignant growth is outlined to such a degree that you can make a decision as to the extent of the malignancy and the treatment required.

I can find no cause to disagree with either of the preceding papers for their experience so nearly parallels our own.

Perhaps we see less cancer of the ear in the South and Southwest than occurs in the North because of your biting winter winds. On the other hand, no doubt we see more involvement of the alae of the nose, face and subauricular areas due probably to the accumulation of sand and other external irritants.

Such cases always put the physician to his most searching test in choosing the best procedure for the particular case.

DR. ANDREW H. DOWDY, Rochester, N.Y. Dr. Robinson, in his paper, deals with the entire gamut of treatment of carcinoma of the skin overlying the nose. All that I can do is to emphasize one or two of the points which he has brought out in his paper.

In the first place, he emphasized very strongly that there is no one way to treat carcinoma in this region. That is perfectly true. One must be able to analyze the physical characteristics of the tumor and then use the method which he has at hand which will give the best results.

There are two primary considerations: first, the complete eradication of the primary tumor; and second, the choice of the method or methods which will best do this and give the best cosmetic result.

If complete eradication means the loss of some prominent feature of the face, such as the ala of the nose, this should not deter one from adequate treatment because with prosthesis, or later with plastic surgery, repair can be made.

Another point which he didn't bring up—and I am very glad he didn't, because I believe that at least there should be a partial emphasis on that point—he made no distinction between the sensitivity between a basal cell carcinoma and a squamous cell carcinoma, and I do not believe one should, for several reasons:

In the first place, I believe the physical factors of the tumor are more important than

whether it is a basal cell or squamous cell. Superficial lesions of either type will respond to moderate irradiation. Deep, ulcerating, infiltrating lesions of either type will be more difficult to eradicate, particularly if the cartilage has been involved.

You may take a biopsy from one side of the lesion and find it is basal cell. If you belong to the school in which you feel the basal cells are more sensitive, you might undertreat the lesion, because on the other side there might be squamous cell elements in this carcinoma.

Dr. Robinson's paper and Dr. Driver's paper also emphasized the fact that we can give adequate irradiation to a carcinoma overlying cartilage without the fear of subsequent cartilaginous necrosis. I do not believe this point is as generally recognized as it should be. One should not fear subsequent cartilaginous necrosis unless the carcinoma has ulcerated and infiltrated the cartilage. Then one may get a necrosis. Not necessarily so, however, because we have treated and I am sure a number of you have seen large lesions involving the cartilage with infection which have responded quite well to radiation therapy.

At the present time we are passing from the period of empiricism plus art to the period of science plus art in the treatment of many tumors. Particularly is this true in the treatment of skin cancer, and this is largely due to the excellent work done by the physicists—particularly Dr. Quimby and her co-workers—so that now we are able to deliver into the tumor a given specific minimal dose, certainly in skin cancer, and it is the tumor dose, the minimal tumor dose, which is important. The skin dose and multiple portals are only an accessory to the end.

I believe the failures in the past have been due to one or more of four factors: (1) inadequate consideration of the physical characteristics of the tumor; (2) improper selection of the method or methods to be used in the treatment; (3) inadequate inclusion of a sufficiently wide margin of apparently normal tissue around the circumference of the tumor, and (4) inadequate dosage.

Failure to observe any one or more of these may lead to a recurrence and certainly the first treatment is the time of the golden opportunity.

I would like to ask Dr. Robinson one question, if he has had a similar complication that we have noticed in the past: We irradiated a rather large ulcerative, indurated tumor lying at the base of the nose in the region of the inner canthus overlying the nasal lacrimal duct. We were able to obtain a very beautiful cosmetic result but within six or eight weeks the patient began to complain of epiphora resulting from obstruction of the nasal lacrimal duct. I would like to know if he has a similar complication and, if so, what method he has used in controlling it;—if simple dilatation was used, how soon after the completion of treatment was dilatation used and how frequently was it carried out.

Dr. Driver (closing). I want to mention first that in regard to the use of the heavier voltages of roentgen rays, 220 to 200 kv., those treatments have been given for us by Dr. Freedman of the Department of Radiology of Lakeside Hospital. We do not have that type of apparatus and also, not in the cases reported here but in some of the cases on our service that have been treated at City Hospital, these higher voltages have been used by Dr. Hauser.

Dr. Lain brought out the point about Dr. Cole and me being rather skeptical about the use of radiation over cartilage a number of years ago and that certainly is true. I attempted to bring that out in the paper,—that our ideas on that have changed just the same as a great many other people have changed their ideas on that point.

I was grateful to Dr. Dowdy for bringing up the point in regard to the causes of failure and that there are certain principles we must keep in mind in treating these cases. I think that that is really the important thing in the treatment of epithelioma of the skin in general.

When it comes to deciding whether one will use radium or roentgen radiation or whether to use it by surface application or interstitial irradiation, these principles that he brought out come into play. I do not think it makes a lot of difference whether one uses roentgen rays or radium. I think the results in many instances are comparable. However, we must keep in mind these things in deciding the voltage to use, the filtration to use and the dose to use. If we do this, I am sure that any of these methods will give satisfactory results.

EPITHELIOMA OF THE LIP METASTATIC TO THE VERTEBRA

REPORT OF TWO CASES

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WE RECENTLY observed 2 patients with epithelioma of the lower lip, who suffered from metastasis to the vertebra. One of these was in a female. So far as we have been able to ascertain, no such case has been previously reported.

Warren collected 73 cases of epithelioma of the lip, 4 of which were in females, 3 of whom were smokers. Fricke reported 1,338 cases with 91 per cent in males and 9 per cent in females.

Epithelioma of the lip is quite uncommon in females and in both sexes metastasis to bone is very rare and to the vertebrae exceedingly rare. The rarity of this condition justifies reporting what would otherwise be a common condition.

FIG. 1. Lateral roentgenogram of the dorsolumbar region of the spine, showing destruction and compression of the body of the first lumbar vertebra, in a female with epithelioma of the lip.

Ewing, in the latest (1940) edition of Neoplastic Diseases, discusses metastasis of epithelioma of the lip, not mentioning metastasis to bone, as follows:

> Metastatic invasion of lymph nodes in lip cancer occurs rather late and shows a close relation to the size of the lesions and the grade of malignancy. Invasion of the submental and submaxillary lymph nodes is prior to the invasion of the deep cervical. Metastatic nodes developed after hospital admission in 3 out of 224 patients who had lesions of from 1 to 1.5 cm.; 4 per cent of 276 lesions of all sizes yielded metastasis after from one to seven years; late metastasis occurred in 13 per cent of 61 patients who had lesions of from 1.5 to 3 cm.; and metastasis occurred subsequent to hospital admission in 2 (10 per cent) out of 20 patients who had lesions larger than 3 cm. (Richards). In Grades I and II, Broders found 11 per cent with metastasis; in Grades III and IV, 66 per cent.

In a personal communication, Dr. William S. MacComb states:

> In our records at Memorial Hospital, there are thirteen autopsies performed on patients who died of cancer of the lip. In only two of these were there distant metastases and in one metastasis to the bone (the humerus). Six of the thirteen cases had regional node metastases.

That epithelioma of the lip does enter the blood stream and metastasize to bone is shown by the records of the Memorial Hospital. That very rarely the malignant cells enter and destroy the vertebrae is shown by the 2 cases reported here. Both of these cases had extensive metastases to the adjacent lymph nodes prior to the blood borne metastasis to the vertebra.

REPORT OF CASES

Case I (No. 21611). Mrs. P. B., aged thirty-three. When this patient first came (January 17, 1924) she had a small indurated ulcer in the skin on the right side of the chin which had been present for eighteen months. This area healed in a short time following irradiation with low voltage roentgen rays.

On January 9, 1930, the patient returned with an indurated area 1.5 cm. in diameter on the mucocutaneous border of the right half of the lower lip. This was excised surgically and healed by primary union.

On May 18, 1931, she returned with a small recurrence in the scar. This was cauterized.

On October 8, 1932, there was considerable induration along the scar involving the full thickness of the lower lip. Surgical excision was done after the technique of W. W. Grant with sliding of the cheeks forward to close the defect. Healing occurred by primary union.

Microscopical examination of the tissue removed showed squamous cell epithelioma.

On September 10, 1936, recurrence appeared along the buccal and labial side of the mandible. This was cauterized.

On January 21, 1941, the patient returned complaining of pain in the back, and physical examination revealed a sharp kyphosis at the dorsolumbar junction.

A roentgenogram made in the lateral position showed compression of the body of the first lumbar vertebra (Fig. 1).

Case II (No. 47029). C. L., male, aged fifty. Two years before coming to us (July 21, 1936) he developed a sore about 1 cm. in diameter on the left half of the lower lip which was removed elsewhere by caustic. Further treatment by caustic was refused. One month ago he developed paralysis of both lower legs, and lost control of the bowels and bladder.

Examination revealed previous destruction of the entire lower lip down to the gingivobuccal fold which healed leaving a soft pliable scar.

Fig. 2. Lateral roentgenogram of the lower dorsal region of the spine, showing destruction and compression of the body of the tenth dorsal vertebra, in a male with epithelioma of the lip.

There was another deep scar in the left submaxillary region. The point of the chin and submental region was occupied by a large subcutaneous mass over which the skin was a reddish color. A sharp kyphosis was present in the lower dorsal region, the bladder was distended well above the pubes and the urine dribbling.

Roentgenograms of the spine revealed a destructive process involving the body of the tenth dorsal vertebra with marked compression (Fig. 2).

ASPIRATION AND SURGICAL BIOPSY

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THE diagnosis of cancer is based on pathological examination. Nevertheless in many cases pathological examination following surgical biopsy is difficult to perform because the removal of a small fragment of tumor means discomfort to the patient and many of them refuse this procedure. Moreover, the danger of disseminating tumor cells after the surgical operation is another reason for sometimes avoiding a surgical biopsy. If the tumor is a deep-seated one or is adherent to the neighboring tissues, radical operation is not possible and then a fragment is removed for pathological examination. In such cases there are many possibilities of disseminating the cancer cells. All these inconveniences and dangers are avoided to a great extent by using aspiration biopsy which is sufficient in many cases for a precise diagnosis. We will not give the detailed technique of this procedure for it is practically the same as that described by Dr. Hayes E. Martin of the Memorial Hospital, New York City. The only difference is that in our cases the aspiration is performed without incision of the skin.

FIG. 1. Smeared material from a suspected mammary carcinoma. Confirmed by surgical biopsy.

We will give our experience with aspiration biopsy, comparing the results with those obtained in the same cases by surgical biopsy. This is the only way to appreciate the real value of aspiration biopsy.

In a total group of 34 patients in which the diagnosis of cancer was made after surgical biopsy or postmortem examination, aspiration biopsy gave a positive result in 28 and failed in 6 cases (Table 1).

TABLE I

ASPIRATION BIOPSY

	Positive Cases	Failures
Lymph node tumors	12	1
Metastatic cancer in lymph nodes	4	0
Mammary carcinoma	4	3
Mammary adenoma	2	0
Branchial tumors	2	0
Bone sarcoma	1	1
Sarcoma in soft tissue	1	0
Salivary tumors	1	1
Maxillary antrum	1	0

This means a failure in 17.6 per cent and a correct diagnosis in 82.4 per cent. This is very important. We must not forget the possibility of a failure and therefore a negative result has little or no value.

On studying the failures there are three possibilities: (1) the point of the needle has not entered the tumor; (2) the structure of the tumor is very fibrous and makes its aspiration into the needle difficult; (3) the aspirated material is wrongly interpretated.

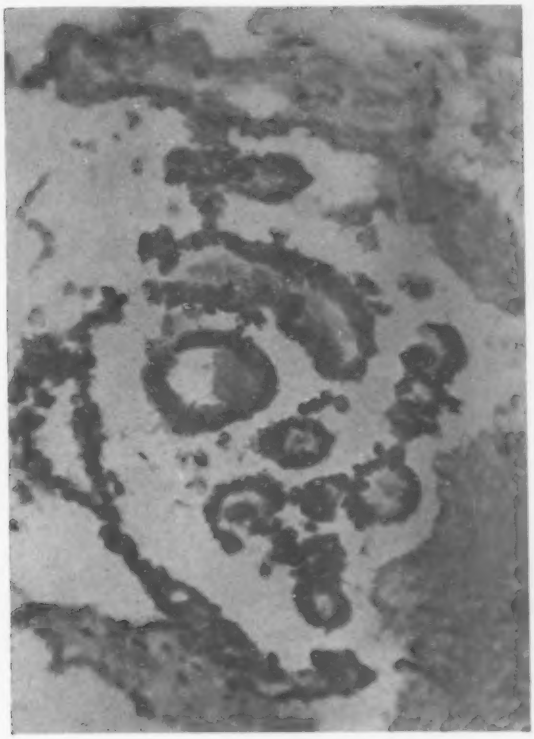

Fig. 2. Smeared material from a mammary tumor. Surgical biopsy showed an adenoma.

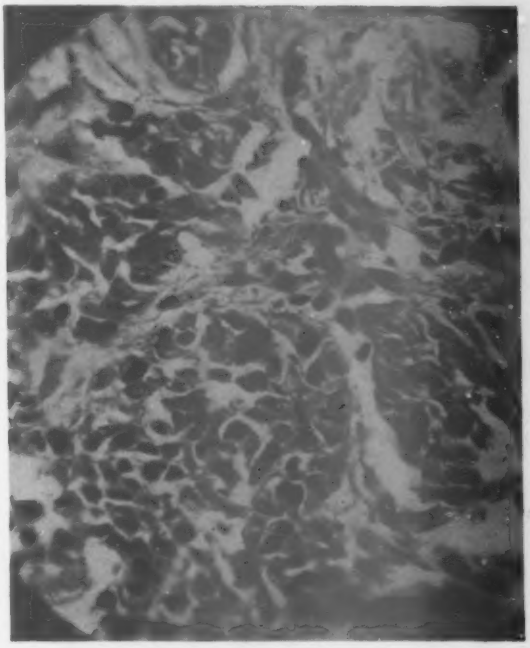

Fig. 4. Section of clot from a suspected mammary carcinoma. Confirmed by surgical biopsy.

The smeared material from an aspiration biopsy can seldom classify the tumor but section of the clot permits a more precise diagnosis.

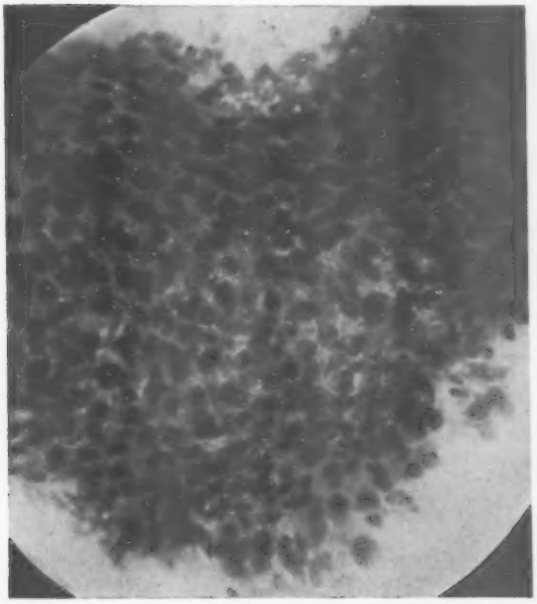

Fig. 3. Smeared material from a suspected tumor in left maxillary antrum. Postmortem examination confirmed a squamous cell carcinoma.

Fig. 5. Section of clot from a lymph node. Surgical biopsy showed a reticulum cell sarcoma (lymphosarcoma).

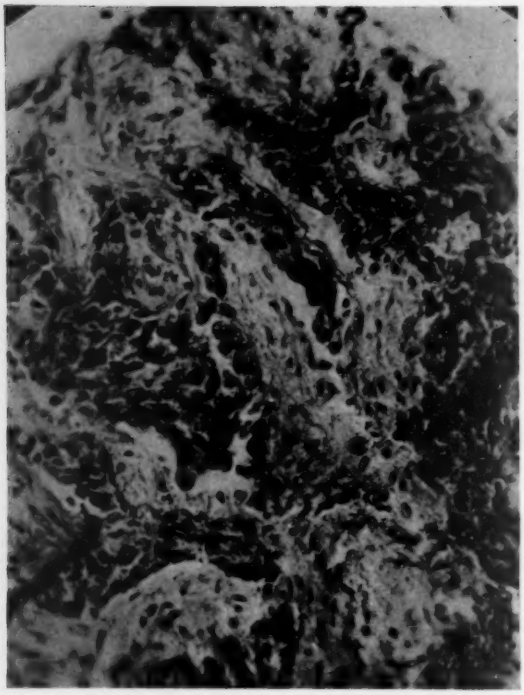

FIG. 6. Section of clot from a lymph node. Surgical biopsy showed a metastatic cancer.

It must be remembered that the relation between neoplastic and normal neighboring tissue cannot often be determined from aspiration biopsy. Therefore the diagnosis of cancer has to be based on cytological examination.

Aspiration biopsy is especially indicated in all neoplastic conditions of the lymph nodes and in early cancer of the breast. If the physician who performs the aspiration biopsy is able to make a diagnosis from the aspirated material so much the better.

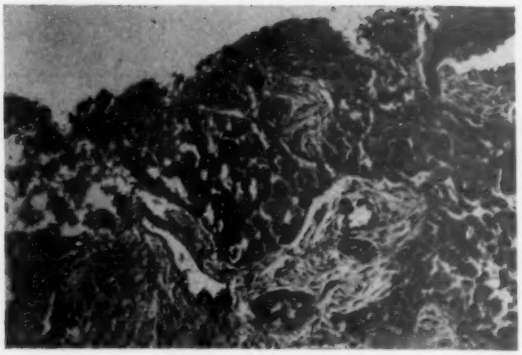

FIG. 7. Section of clot from a suspected cancer of the lung. This case has not been confirmed.

In our cases we have not seen any serious complication due to aspiration biopsy.

SUMMARY

In the small number of cases herein reviewed a comparison is made between surgical and aspiration biopsy. Diagnosis of cancer by means of aspiration biopsy has given a positive or exact result in 82.4 per cent of the cases.

I wish to express my thanks to Dr. L. Guzman, Radium Institute, Santiago, Chile, for his kind help.

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Vol. 48, No. 1

LATE EFFECT OF HIGH VOLTAGE ROENTGEN RAYS ON THE HEART OF ADULT RATS

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INTRODUCTION

THIS study was undertaken for the reason that to date there is only one published record[1] of the late effect of roentgen rays on the heart of laboratory animals. In general, there is, in the minds of many investigators, an unanswered question concerning this aspect of the problem. When one sees the late effects of high voltage roentgen rays on the skin, subcutaneous tissue, muscle and bone, one wonders if the cardiac tissue is to any degree affected in a like manner. This work was done also to augment data on a clinical research problem[3] on the effect of roentgen rays on the human heart. The object of the experiment was to determine if there were any late effects on the heart muscle, especially fibrosis, and on the coronary system, particularly thrombosis, sclerosis or periarterial fibrosis.

A previous study[4] on the immediate effects of high voltage roentgen rays on the heart of rats showed the following:

(1) The lethal dose when the heart alone was irradiated was 10,000 roentgens or more delivered in a single dose.
(2) The myocardial changes were hemorrhage, myocardial degeneration, and round cell infiltration.
(3) The pericardium and endocardium showed no gross or microscopic evidence of damage following doses up to and including 20,000 roentgens.
(4) The lobular pneumonia that resulted from the irradiation played little or no rôle in the changes seen in the heart.

LITERATURE

There are many reports in the literature on the effect of high voltage roentgen rays on the heart, but with the exception of Domagk's experiments,[1] they are all primarily concerned with the immediate or almost immediate changes that occur following irradiation. Domagk irradiated the entire animal and noted myocardial fibrosis in the surviving animals. The observations of others on the early results of irradiating the heart have already been reviewed[4] and need not be repeated.

METHOD OF STUDY

A total of 24 adult male and female rats (Sherman strain) was used for this study.

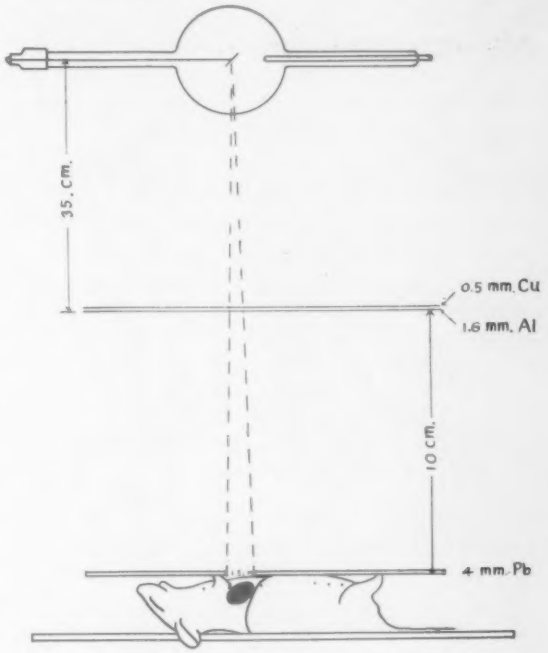

FIG. 1

They were irradiated in the following manner. The animals were firmly fixed to a stiff pasteboard with adhesive straps and were completely immobilized during the time they were treated. They were then covered with a specially constructed shield of lead 4 mm. thick with 1 mm. of celluloid

attached to the under surface. There was an aperture in the shield measuring 1 by 1.5 cm. and this was placed directly over the heart which was previously located by palpation in each animal. Thus, all of the animal except the precordial area was protected from the beam of radiation (see Fig. 1).

The source of radiation was a standard water-cooled Coolidge roentgen tube with the following factors: 200 kv., 30 ma., a filter of 0.5 mm. Cu plus 1.6 mm. Al. At 45 cm. target-skin distance the intensity of radiation was 69 r per minute; at 31 cm., 146 r per minute.

Using these factors of irradiation, the depth dose reaching the anterior cardiac wall of the animals was 90 per cent, and the posterior cardiac wall received 75 per cent. In the human subject the skin erythema dose is 750 r but in the rat one can only detect epilation which begins at 1,500 r.

The animals received the following single doses:

No.		
3	750 r	to the precordium
4	1,500 r	to the precordium
4	3,000 r	to the precordium
3	5,000 r	to the precordium
3	7,500 r	to the precordium
1	20,000 r	of unfiltered radiation to the thigh
2	1,500 r	to the upper portion of the right lung

(Roentgens measured in air)

4 remaining animals were placed in the same cages and were used as controls.

A careful record was kept of the animal's general condition, weight, and duration of life following this procedure.

Some of the animals died during the course of the experiment. They were examined as quickly as possible postmortem. The surviving animals were sacrificed at intervals ranging from four to fifteen months after irradiation.

After gross examination, the tissues were immediately placed in formalin, fixed in paraffin, and many sections of each heart were stained with hematoxylin and eosin, and others were stained with Weigert's fibrous tissue stain. The results of the microscopic study were then recorded, but the examiner did not know which sections represented animals that were controls, animals that received small doses, or animals that received large doses of radiation.

EXPERIMENTAL DATA*

750 r. Three rats received 750 r of filtered roentgen rays through the precordial area. They were killed at intervals of twelve months, fourteen days; thirteen months, eighteen days, and fourteen months following this procedure.

No gross changes were seen.

Microscopically, the pericardium, endocardium, and myocardium of all the animals were normal. There was no evidence of increased fibrous tissue and the coronary vessels were normal. The lungs of one animal showed a few small areas of edema, and in another there were a few small foci of pneumonia. The livers of all the animals were normal.

1,500 r. Four rats received 1,500 r to the precordial area in the usual manner. Two were sacrificed at intervals of thirteen months, twelve days; and thirteen months, twenty-five days after irradiation. One animal died nine months, twenty-seven days; and one died thirteen months, eight days after irradiation.

Grossly, in the animals that were sacrificed, no abnormalities were seen. In the animals that died, there was wasting of the subcutaneous tissues and the lungs were darkly congested.

Microscopically, the hearts of all the animals were normal. There was no increase in fibrous tissue and the coronary vessels were normal.

The lungs of the surviving animals showed a few scattered areas of pneumonia. In one animal there was a moderate sized hemorrhage in the left lung. In the animals that died, the lungs showed edema, pneumonia and hemorrhage. The livers of all the animals were normal.

3,000 r. Four adult rats received 3,000 r of filtered roentgen rays through the precordial area in a single exposure. One animal died twelve months, twenty days after irradiation. The 3 remaining animals were sacrificed at intervals of six months, eleven days; six months, eleven days; and thirteen months, eighteen days, respectively, after irradiation.

* The following is of interest only to those who might wish to repeat these experiments. A summary of the pathological findings is given in Table 1.

The animal that died was examined thirty-six hours postmortem. Grossly, the lungs were dark, mottled red. The heart was dark and flabby. The 3 surviving animals presented no unusual features except for a moderate number of small, pinpoint subpleural areas of hemorrhage. The hearts were normal.

Microscopically, the heart of the animal that died showed poorly staining muscle fibers and granular degeneration. The coronary vessels were normal and there was no increase in fibrous tissue about the vessels or in the myocardium. The hearts of the other animals were normal. The lungs of the animal that died showed hemorrhage, edema and pneumonia. The lungs of the sacrificed animals showed small areas of pneumonia. The liver of one of the surviving animals showed multiple small areas of round cell infiltration and focal necrosis.

5,000 r. Three rats received 5,000 r of filtered high voltage roentgen rays through the precordium in single doses. One died five months and thirteen days later. One was killed two months, eight days; and one six months, eleven days after exposure.

The animal that died lost weight at the five month mark and died eleven days later. The two surviving animals were in good health at the time they were sacrificed.

Grossly, in the animal that died, the heart was dark and flabby, and the lungs were moderately congested. In the surviving animals there were no marked abnormalities except in the lungs where there were scattered subpleural hemorrhages.

Microscopically, the hearts of all the animals were normal. The coronary vessels were unchanged and there was no increase in fibrous tissue about the vessels or in the myocardium. The lungs of the animals that were sacrificed showed a few scattered areas of edema and hemorrhage. The lungs of the animal that died showed multiple areas of pneumonia and atelectasis. The livers of all the animals were normal.

7,500 r. Three rats received 7,500 r through the precordial area with the usual technique. One died three months, eleven days after irradiation. One was killed four months, eight days; and one six months, eleven days after irradiation. The one that died lost weight steadily after being irradiated. The 2 surviving animals were in good condition throughout the course of the experiment.

Grossly, the heart of the animal that died was dark and flabby and engorged with blood, and the lungs were dark and congested. The hearts of the animals that survived were normal and the lungs were normal.

Microscopically, in the heart of the animal that died there was moderate capillary congestion but no evidence of muscle change or hemorrhage. The coronary vessels were normal. There was no increase in fibrous tissue. The hearts of the surviving animals were normal in all respects. The lungs of the animal that died were congested, hemorrhagic and edematous and showed some scattered areas of consolidation. The lungs of the surviving animals contained many small areas of pneumonia. Sections of the liver of one of the surviving animals showed multiple small areas of focal necrosis with round cell infiltration. These changes were similar to those seen in the animal that received 3,000 r. The livers of the other 2 animals were normal.

1,500 r. Lung. The animals received 1,500 r to the upper portion of the right lung. With this dose one can produce a moderately severe pneumonia in all rats. One died seventeen days after irradiation and one was killed 349 days after irradiation.

Grossly, the right lung of one of the animals was dark and hemorrhagic. The other lung was apparently normal. The lungs of the other animal were unchanged.

Microscopically, the hearts of both animals were normal in all respects. The right pneumonic lung showed a large area of necrosis with surrounding hemorrhage and edema, while the left lung was unchanged. The lung and the liver of the other animal were normal.

20,000 r. Thigh. One animal received 20,000 r of unfiltered high voltage roentgen rays to the right thigh muscles in a single dose. This produced a large infected necrotic area that took many weeks to heal completely. This animal was sacrificed fourteen months, twenty-four days after exposure.

Grossly, the only abnormality was the scarring and atrophy of the thigh muscles.

Microscopically, the heart was entirely normal. The lungs showed a few small areas of hemorrhage and edema. The section of thigh muscle taken just adjacent to the scarred area showed only one thrombosed arteriole but no increase of fibrous tissue or peculiar reaction in the muscle bundles themselves. The atrophic scarred area showed acellular fibrous tissue.

TABLE I

RÉSUMÉ OF MICROSCOPIC FINDINGS

Rat No.	Dose in Roentgens	Days Killed; Died after Irradiation	Changes in Heart	Changes in Lungs	Changes in Liver	Cause of Death	Rat No.
1	750	374 K*	o	o	o		1
2	750	408 K	o	o	o		2
3	750	420 K	o	o	o		3
4	1500	402 K	o	Pn. 1+L, Hem. lung	o		4
5	1500	402 K	o	Pn. 1+	o		5
6	1500	297 D	o	Ed., Hem., Pn. 3+	o	Pneumonia	6
7	1500	428 D	o	Ed., Pn. 3+	o	Pneumonia	7
8	3000	380 D	Poorly stained myocardium**	Ed., Pn. 3+	o	Pneumonia	8
9	3000	191 K	o	Pn. 1+	Focal necrosis, fibrosis		9
10	3000	191 K	o	Pn. 1+	o		10
11	3000	408 K	o	Pn. 1+	o		11
12	5000	163 D	o	Pn. 2+Atelect.	o	Pneumonia	12
13	5000	68 K	o	Hem. 1+Ed. 1+	o		13
14	5000	491 K	o	Hem. 1+Ed. 1+	o		14
15	7500	101 D	o	Hem. 2+Ed. 2+	o	Pneumonia	15
16	7500	128 K	o	Pn. 1+	o		16
17	7500	491 K	o	Pn. 1+	Focal necrosis, fibrosis		17
18	20000 thigh	444 K	o	Hem. 1+Ed. 1+	o		18
19	1500 lung	349 K	o	Hem. 2+Necr. 2+	o		19
20	1500 lung	171 D	o	Pn. 1+	o	Pulmonary abscess	20
21	Control	D	o	Pn. 3+	o	Pneumonia	21
22	Control	K	o	Hem. 1+Ed. 1+	o		22
23	Control	K	o	Hem. 1+Ed. 1+	o		23
24	Control	K	o	Hem. 1+Ed. 1+	o		24

K—Killed by blow on head
D—Died
Pn.—Pneumonia
Ed.—Pulmonary edema
Hem.—Hemorrhage

1+—Scattered areas
2+—Moderate number of areas
3+—Diffuse throughout lung
**—Examined 48 hours postmortem

Controls. Four control animals were kept in the same cages with the irradiated animals, and were subjected to the same environmental conditions and diets. One animal died five months, seven days after the start of the experiment. Three were killed fourteen months after starting the procedure.

The animal that died had some pulmonary infection. The others were in good condition when sacrificed.

All of the hearts were normal microscopically except in one instance where the wall of one of the coronary arteries had an abnormally thick medial coat, measuring 40 microns. The intima was intact and unchanged. There was no evidence of fibrosis of the myocardium in any of the sections. The lungs of the surviving animals showed many small areas of edema and hemorrhage. The sections of liver of these animals were normal. The lungs of the animal that died showed diffuse hemorrhage and edema throughout. The central veins of the hepatic lobules and sinusoids were moderately congested.

Table 1 is a summary of the microscopic changes observed.

DISCUSSION

From the results obtained by the gross and microscopic examination of these animals, both in the treated and the control groups, several facts are outstanding.

The pericardium, endocardium and myocardium, including the coronary vessels, can withstand large single doses of high voltage roentgen rays without any appreciable change late in the post-irradiation period. There was only one instance in all of the sections studied where the muscle tissue was affected. This apparently was due to postmortem changes rather than irradiation effect.

The frequency of the pulmonary changes seen in these rats is not unusual. They seem to withstand this type of infection well, and it does not interfere with general health or gain in weight, provided the process is not too extensive. Some of the animals died of massive pneumonia. This included 2 in the group receiving 1,500 r, one treated with 3,000 r, one with 5,000 r and one with 7,500 r, one treated over the right lung, as well as one control animal. It is possible that some of the hemorrhage and edema seen in the lungs was due to agonal changes. In none of these animals was there any toxic, inflammatory or fibrotic change evident in the myocardium indicating a secondary effect of the pulmonary infection on the heart.

The occurrence of focal hepatic necrosis cannot be ascribed to the effect of irradiation. Such changes have been noted in normal rats which have been used as controls in other types of experiments where irradiation was not used.[5]

The object of this particular experiment was to determine if myocardial fibrosis could be produced by relatively excessive doses. The immediate lethal dose has alalready been determined (10,000 r). Since, in the human subject voluntary muscle will undergo atrophy and fibrosis following irradiation with comparable doses of roentgen rays and radium, it seemed entirely possible that cardiac muscle might do likewise. So far as we can determine, this is not true in rats subjected to doses up to and including 7,500 r. It is likely that if one could get enough animals to survive single doses of 10,000 r, known to produce capillary hemorrhage and myocardial edema, some of the hearts would later show replacement fibrosis in the myocardium.

From the studies of the hearts of adult rats subjected to large single doses of roentgen rays both early and late in the post-irradiation period, we have been unable to find any reason why cardiac muscle should be so resistant to roentgen therapy. However, it is admissible to attempt to formulate a theory concerning this resistance.

Histologically there are several important differences between the two types of muscles. In the voluntary muscle the cells consist of long cylinders with peripherally placed nuclei. These tubes are much larger in diameter than the cardiac muscle fibers. The myocardial fibers (also tubular) anastomose freely with each other and the nuclei are centrally placed.

Physiologically, also, the two types of cells differ. While the chemical reaction that causes muscular contraction is the same in both, the voluntary muscle fatigues much more rapidly and finally refuses to contract after a certain time until recovery occurs. During the recovery period certain retrograde chemical reactions take place—resynthesis of muscle glycogen, phosphoric acid, creatinine compound and disposal of the excess lactic acid either by oxidation and diffusion through the cell membrane into the circulation, or resynthesis into glycogen. In the cardiac muscle this reaction necessarily takes place more easily and rapidly and proceeds all during the period while the muscle continues to beat rhythmically.

There is apparently some inherent ability of the cardiac muscle to dispose of its metabolites more easily than voluntary muscle. This may depend in part on the relationship of the limiting membrane to the cell body.

Some time ago Failla[2] suggested the fluid

flow theory for the cause of cell death following irradiation. In brief, it postulated the following points: (1) If a cell that is surrounded by a fluid medium that can circulate is irradiated; (2) there is an increase in the number of intracellular particulate bodies because new ions are formed, (3) water will enter the cell by osmosis and swelling of the cell occurs, (4) there is a disturbance of the relationship of the cell membrane to cell body ratio because of (3), (5) because of this disturbance of the cell membrane to cell body ratio, normal intracellular metabolism is impossible, with consequent cell death.

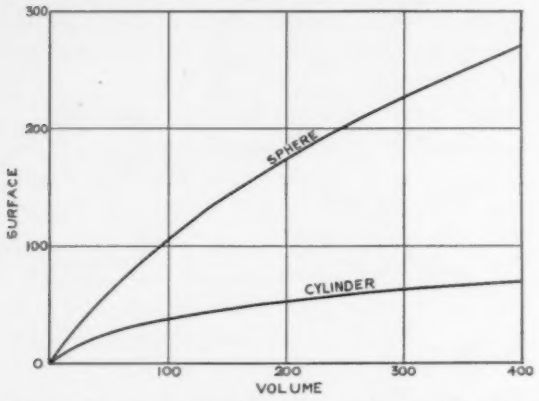

FIG. 2. Curves comparing the surfaces of a sphere and a cylinder (without the ends included) for equal volumes. $2\pi rh$ where $h=1$ was the formula used for the endless cylinders. The ends of the cylinders were not included because, to carry out the analogy, myocardial cells have no ends but are continuous with each other, i.e., they are cylinders without ends. Since any increase in volume in such a cell is largely due to increase in the radius rather than in length, the cylinder length has been kept at 1. On the other hand, as the volume of the sphere increases, the radius increases in all directions.

Actually, a factor tending to lower the values for the surface of the cylinder is that the cells anastomose freely with neighboring cells and reduce the surface still more. A factor tending to raise the values for the cylinder surface is that any increase in the volume of such a cell is due not only to an increase in diameter, but also probably to some increase in length. The rôles that these two factors play offset each other to a certain extent.

We have applied this theory to explain the relative resistance of cardiac muscle to irradiation. Theoretically, steps (2) and (3) occur when cardiac muscle is irradiated. However, because the fibers anastomose freely, swelling of the fibers can occur to a marked degree without much alteration in the relationship of the cell body to the limiting membrane (see Fig. 2). Since the cells are already capable of handling sudden changes in the numbers of molecules present, due to the nature of muscle metabolism, and since the cell membrane to cell body ratio is not altered as much as it would be if each cell were separate, the new ions may be transported across the cell membrane quickly so that they cannot accumulate in the cell body and interfere with normal metabolism.

Experiments have shown that many types of cells will swell shortly following irradiation. It is possible that some slight swelling of the myocardial fibers does occur a few hours after irradiation with doses up to 7,500 r. We have not seen any enlargement of the muscle cells one to two weeks after their being subjected to large doses. In the animals receiving 10,000 and more roentgens, some of which died four to ten days after treatment, one could see swelling and atrophy and coagulation of the cytoplasm all in the same section.

One might deduce on the basis of the fluid flow theory, that the cardiac muscle cells can cope with the increased ionic concentration produced by roentgen rays, up to 7,500 r, and that doses of 10,000 to 20,000 r caused enough higher intracellular concentration to be inconsistent with normal metabolism and cell life.

CONCLUSIONS

1. Adult male and female rats received varying amounts of high voltage roentgen radiation to the heart in single doses.

2. There was no demonstrable effect on the heart two to fourteen months after it had been irradiated with single doses up to and including 7,500 roentgens.

3. There were no late changes observed in the heart of the animals that received radiation to the lungs or thigh muscle.

4. Pulmonary infection, when present, did not cause any demonstrable change in the heart of these animals.

5. The fluid flow theory of Failla has been applied to explain the relative resistance of the myocardium to roentgen irradiation.

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STUDIES IN ROENTGENOGRAPHIC EXPOSURE METER DESIGN*

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FOR many years the need of a simple practical exposure meter for use in roentgenography has been recognized by most radiologists. Until a short time ago efforts to design such an instrument were for the most part unsuccessful, but recent developments in photoelectric equipment are rapidly changing this picture. Indeed, experimental studies in roentgenographic photometry are now being conducted in several centers.

In the few publications that have been written on the subject of roentgenographic exposure meters, little has been said regarding the basic criteria that must be observed in designing these instruments nor have investigations been carried out to determine the means by which these criteria can be fulfilled most satisfactorily. During the past few months such studies have been undertaken in this laboratory and it is hoped that the findings presented herewith will serve as a sound foundation for further work in this field.

The function of an exposure meter is to measure the effective intensity of the radiation with which a film is to be exposed. The exposure time that will insure correct exposure of the film can then be determined from the equation:

$$t = \frac{c}{M s_e} \qquad (1)$$

where

- t is the exposure time in seconds,
- M is the intensity of the radiation as measured by the exposure meter when placed under the anatomical structure to be roentgenographed and when exposed with a roentgen beam identical to that with which the film is to be exposed,
- s_e is the speed factor of the film, and
- c is a constant.

As shown previously,[3] equation (1) is universal in its application and is valid regardless of the anatomical structure under examination and the roentgenographic technical factors involved.

In general, exposure meters consist essentially of two parts. One, a radiation detector, generates or conducts a small electric current in response to the radiation falling on its sensitive surface; the magnitude of the current is governed by the intensity and quality (spectral distribution) of the incident radiation. The second is a microammeter, galvanometer or other current-recording device. When the radiation to be measured is of extremely low intensity (e.g., under roentgenographic conditions), it is necessary to include a third component, a vacuum tube amplifier, to increase the sensitivity of the instrument to an adequate level.

I. RADIATION DETECTORS

In roentgenographic exposure meters, ionization chambers and photoelectric cells* of the photoemissive type (phototubes) have been employed as radiation detectors. The latter devices are relatively insensitive to roentgen rays directly but become highly sensitive to such radiation indirectly when their surfaces are coated with calcium tungstate, zinc sulfide or some other similarly fluorescent material. The relative merits of the two detectors will be discussed presently.

From previous investigations it appears that there are two basic criteria that must be fulfilled by radiation detectors of the roentgenographic type:

* A discussion of the characteristics and constructional details of various photoelectric cells has been published recently by Weyl, Warren and O'Neill.[7]

* From the Division of Roentgenology of the University of Chicago, Chicago, Illinois.

1. Their sensitivity must be as great as possible since the radiation intensities to be measured are extremely small.
2. Their responses must parallel those of roentgen films exposed with or without intensifying screens through the complete range of radiation quality used in medical roentgenography.

As previously shown,[3] the second of these criteria is of major importance for unless it is closely observed exposure meter readings cannot be substituted directly in equation (1) to obtain the correct exposure time of a film but first must be multiplied by a correction factor, the value of which is dependent on the quality of the radiation exposing the film. Since quality of radiation varies within wide limits and cannot be easily determined, it is obvious that an exposure meter in which the radiation detector does not fulfill the second criterion has little value from a practical standpoint.

To determine the effectiveness with which various radiation detectors fulfill the first criterion, the responses of a 2 cc. ionization chamber of the type used in the Victoreen r meter and of an R.C.A. 929 phototube to whose surface were applied strips, 2.5 cm. square, of various commercial fluoroscopic and front type intensifying screens were measured through a wide range of roentgen-ray quality. The results of this study are shown in Figure 1, where comparative rather than actual responses are plotted because the former lend themselves to easier interpretation.

It will be observed that quality of radiation has been expressed in terms of the half-value layer of aluminum. This method has been used because of its simplicity and convenience and although it is true that two beams of different spectral distribution can have identical half-value layers, it is believed that the use of the method is justified because this investigation is purely a comparative study and all measurements made at a particular half-value layer were taken with identical roentgen-ray beams. The softest radiation used was an unfiltered beam emitted from a full wave, valve rectified, roentgen generator operating at 30 kv. (peak) and had a half-value layer of 0.33 mm. of aluminum; the hardest was emitted from the same system operating at 90 kv. (peak) and filtered through 4 cm. of aluminum and had a half-value layer of 9.5 mm. of aluminum. To be certain that

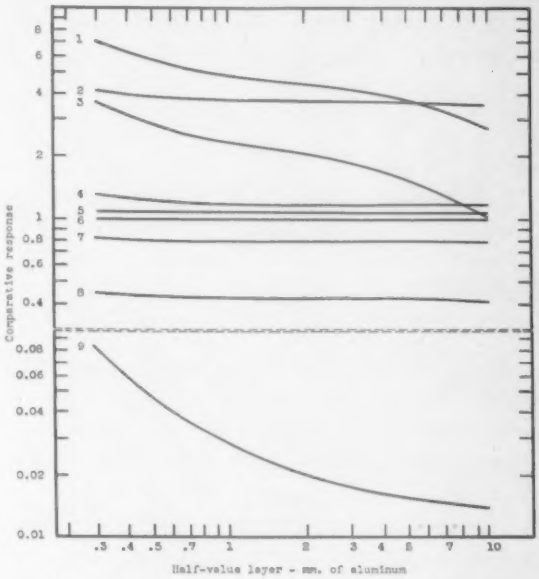

Fig. 1. Comparative responses of various radiation detectors exposed to radiation through the range of quality used in medical roentgenography: *1*, 929 phototube and Patterson photo-roentgen screen; *2*, 929 phototube and Patterson type "B" fluoroscopic screen; *3*, 929 phototube and Patterson fluorazure screen; *4–8*, 929 phototube and various commercial front type calcium tungstate intensifying screens; *9*, 2 cc. Victoreen ionization chamber. Standard of comparison: 929 phototube and Eastman front type ultra-speed intensifying screen.

this range of quality exceeded that used in medical roentgenography, half-value layer determinations were carried out on radiation emitted from a roentgen generator operating at 90 kv. (peak), filtered through various anatomical structures and carefully diaphragmed to reduce to a minimum the secondary radiation impinging on the ionization chamber. The maximum value encountered was 8.0 mm. of aluminum in the lateral lumbosacral spine projection of a living subject 35 cm. in thickness.

The standard of comparison used in the

preparation of Figure 1 was a radiation detector comprising an R.C.A. 929 phototube and an Eastman front type ultra-speed intensifying screen. For convenience this combination henceforth will be referred to as the standard radiation detector. The comparative responses of the other phototube-screen combinations and of the ionization chamber were determined from the equation:

$$\text{Comparative response} = \frac{P}{P_o} \qquad (2)$$

where

P is the current output of a given radiation detector exposed to a particular quality of radiation, and

P_o is the current output of the standard radiation detector exposed to an identical beam.

It will be noted that among the detectors investigated, those employing Patterson photo-roentgen, type "B" fluoroscopic and fluorazure screens provide the greatest sensitivity. Second, the comparative responses of the detectors in which calcium tungstate intensifying screens and the type "B" fluoroscopic screen were used are essentially constant and therefore parallel that of the standard detector through the range of quality shown; the significance of this finding will be discussed shortly. It is also interesting to observe that the response of the ionization chamber is considerably lower than those of the phototube-screen combinations.

The sensitivity of an ionization chamber can be improved in several ways. These include increasing the volume of the chamber, placing the gas within the chamber under pressure and employing gases other than air. Nevertheless, it is extremely doubtful whether ionization chambers can serve as suitable roentgenographic radiation detectors except under limited conditions. This is due to the fact that roentgenographic films are essentially two dimensional whereas ionization chambers also exhibit depth. To understand the importance of this difference, consider for a moment a roentgen beam that has passed through an anatomical structure and is impinging on a roentgenographic film and on an ionization chamber placed immediately below. The intensity of the radiation at the incident surface of the chamber is essentially equal to that at the film surface. However, as the radiation passes through the chamber its intensity diminishes due to the operation of the inverse square law relating intensity and the distance of the radiation from its source. Although this attenuation is negligible for the primary roentgen beam, it may be large for the scattered radiation whose point of origin is in the nearby anatomical structure. Thus the average intensity of the radiation through the volume of the chamber will differ from that at its incident surface by an amount that varies with the quantity of scattered radiation that is present. Because it is the average intensity that governs ionization current, it is clear that discrepancies will occur between the responses of the ionization chamber and of the roentgenographic film depending on the conditions encountered. This difficulty can be avoided if the depth of the chamber is small compared to its surface area, but under this condition the sensitivity of the device becomes so low that its use is not justified in most cases.

The various determinations from which Figure 1 was prepared were made with but one type of phototube. Because in general the spectral distribution of light emitted by fluorescent screens is independent of the quality of the activating roentgen radiation, curves derived from measurements made with other phototubes would have essentially the same forms as those shown. The particular phototube employed in these studies was chosen for its high sensitivity, particularly in the blue portion of the spectrum.

The effectiveness with which the various radiation detectors fulfill the second criterion was determined in the following way. Several brands of roentgenographic film exposed with and without intensifying screens through the range of radiation quality outlined above were subjected to sensito-

metric examination. The various films were exposed by the aluminum ladder method proposed by White,[8] processed simultaneously in a pictolhydroquinone developer for five minutes under constant agitation at a temperature of 65° Fahrenheit and dried under constant conditions.[9] The intensities of the radiation with which the films were exposed were measured by exposure meters employing the various radiation detectors. These intensities were of the same order of magnitude as those employed in routine roentgenographic practice and, to avoid errors in the sensitometric calculations introduced by reciprocity law failure of the films, differed from one another by not more than a factor of 3. The densities of the films were measured with a photoelectric densitometer and corrected for fog. From these data sensitometric curves (density vs. log exposure) were prepared and the exposures required to produce film densities of 1.0 were determined. The speed factors* of the various films and film-screen combinations were then calculated from the equation,

$$s_e = \frac{d}{E_{1.0}} \qquad (3)$$

where

d is an arbitrary constant of such magnitude that the various values of s_e fall within a convenient range of numbers, and

$E_{1.0}$ is the exposure required to produce a film density of 1.0

Since the values of $E_{1.0}$ employed in equation (3) are determined from measurements derived from exposure meter readings which do not necessarily represent the photographic flux densities received by the films, it follows that the speed factor of a film will not be independent of radiation quality unless the spectral response of the film is identical to that of the radiation detector used in the exposure meter. Wilsey[10] has pointed out that a difference of approximately 10 per cent in the exposures received by two roentgenographic films is required to produce perceptible differences in film blackening. It can therefore be stipulated that a radiation detector satisfies the second criterion only if the speed factors of films are maintained within ±10 per cent of constant levels through the entire range of radiation quality used in medical roentgenography.

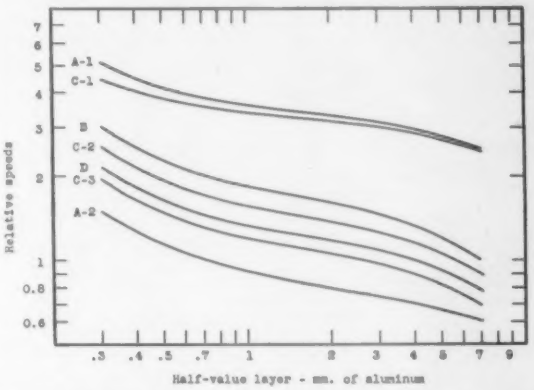

Fig. 2. Relative speeds of seven commercial types of roentgenographic film exposed to roentgen rays directly. The intensities of the radiation with which the various films were exposed were measured with an instrument in which the radiation detector comprised a 929 phototube and an Eastman front type ultra-speed intensifying screen. Since the film speeds do not remain constant, such a detector is not suitable for roentgenographic exposure meter service when non-screen filming techniques are employed.

The speed factors of seven brands of roentgenographic film *exposed without intensifying screens* are shown in Figure 2. Letters rather than manufacturers' names are used to designate the films and the succeeding numbers indicate particular types of film made by the given manufacturer. For example, A-1 and C-1 are so-called non-screen films intended by the manufacturers solely for non-screen service. The intensi-

* Several methods by which the speed factors of photographic films can be determined have been described. An excellent summary of this subject has been written by Mack and Martin.[2] Most of the proposed methods depend on the rather constant forms of the sensitometric curves of photographic films and accordingly are not suitable for use in roentgenography because the forms of the sensitometric curves of films exposed with and without intensifying screens differ markedly from one another. It appears that the most suitable method by which the speed factors of roentgenographic films can be determined is that which is based on the general law that the speed of a film is inversely proportional to the exposure required to produce a particular film density; usually a density of 1.0 is specified since this represents the average density of the diagnostic portions of most roentgenographic films.[1]

ties of the radiation with which the films were exposed were measured with an instrument employing the standard radiation detector (929 phototube and an Eastman front type ultra-speed intensifying screen). It will be seen that the various curves are closely parallel with one another but at

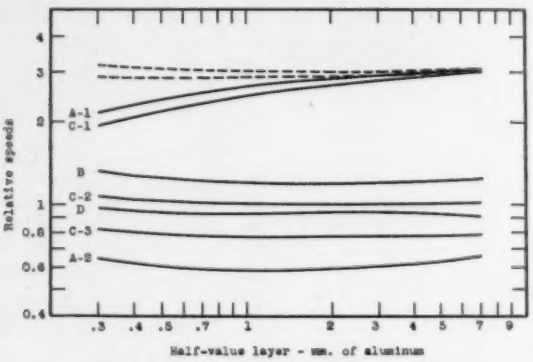

Fig. 3. Relative speeds of the same films represented in Figure 2. Radiation detector: 929 phototube and Patterson fluorazure screen. The broken lines indicate the speeds of the A-1 and C-1 films when the radiation detector also includes an aluminum filter, 0.4 mm. in thickness. The constancy of the various film speeds indicates that the phototube-fluorazure screen combination is an ideal detector for roentgenographic exposure meter service when non-screen filming techniques are employed.

no point through the range of quality shown do the film speeds even approach a constant level. Thus the standard radiation detector is not suitable for roentgenographic exposure meter service when films are to be exposed without intensifying screens. This is as one would expect for it is well known that the responses of films exposed to roentgen rays directly do not parallel those of films exposed with calcium tungstate intensifying screens.

In Figure 3 are shown the curves representing the speed factors of the same films presented in Figure 2 but derived from measurements obtained with an instrument in which a Patterson fluorazure screen was employed in the radiation detector. The speed factors of the five so-called all-purpose films now remain constant well within ±10 per cent through the complete range of quality. As seen by the dotted lines, the speed factors of the non-screen films, A-1 and C-1, remain similarly constant if an aluminum filter, 0.4 mm. in thickness, is incorporated into the radiation detector to reduce the response of the device to soft radiation.

The excellent manner in which the phototube-fluorazure screen combination satisfies the second criterion when films are to be exposed *without intensifying screens* could be predicted from the marked similarity in the forms of the curves in Figure 2 and of Curve 3 in Figure 1. From an inspection of Curve 9 in Figure 1, it is at once evident that the ionization chamber is not a suitable radiation detector for use in exposure meters where non-screen filming techniques are employed, nor can this condition be readily corrected through the use of aluminum or other filtration.

The speed factors of five films exposed with a pair of Eastman hi-definition inten-

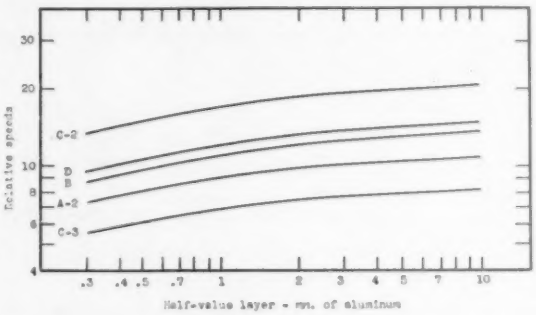

Fig. 4. Relative speeds of five commercial types of roentgenographic film exposed with Eastman hi-definition intensifying screens. Radiation detector: 929 phototube and an Eastman front type ultra-speed intensifying screen.

sifying screens are shown in Figure 4. The intensities of the radiation with which the films were exposed were measured with the same system as that with which the curves in Figure 2 were obtained. The forms of the five curves are almost identical. This is to be expected for as previously pointed out the spectral distribution of the radiation emitted by an intensifying screen is relatively independent of the quality of the activating roentgen radiation and accord-

ingly differences in the relative spectral sensitivities of various films do not have an opportunity to manifest themselves. The speed factors of the films increase gradually as the radiation becomes harder. That this is due to a gradually increasing response of the back screen when exposed to radiation of decreasing wave length is well shown in Figure 5. Curve 1 represents the speed factors of an Eastman blue brand roentgen film exposed with the customary front and back pair of Eastman hi-definition intensifying screens, whereas Curve 2 represents the speed factors of the same film exposed with a front screen only. The difference between the two curves indicates the contribution to film blackening by the back

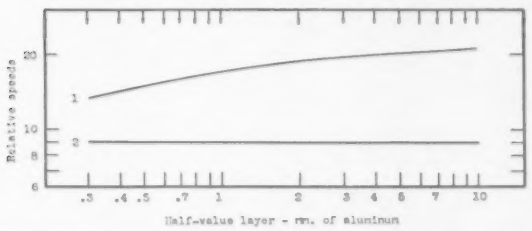

Fig. 5. Relative speeds of Eastman blue brand roentgen film: *1*, exposed with both front and back Eastman hi-definition intensifying screens; *2*, exposed with a front screen only. Radiation detector: 929 phototube and an Eastman front type ultra-speed intensifying screen.

screen and is seen to increase slowly as the radiation becomes harder.

In passing, it is interesting to note that a comparison of the curves presented in Figures 2 and 4 confirms most strikingly the observations of others[5,6] that the intensification factor of a pair of intensifying screens is not a fixed quantity but is dependent on the quality of the radiation and the particular type of film with which the determination is made.

The curves representing the speed factors of Eastman blue brand roentgen film exposed with eight commonly used types of intensifying screens are presented in Figure 6; as before, radiation intensities were measured with the standard radiation detector. These curves, like those in Figure 4 have gradually decreasing upward slopes but are not exactly parallel with one another due to differences in the construction

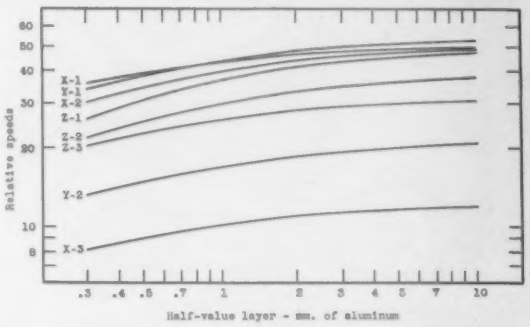

Fig. 6. Relative speeds of Eastman blue brand roentgen film exposed with eight commercial brands of intensifying screens. Radiation detector: 929 phototube and an Eastman front type ultra-speed intensifying screen.

of the various screens. The screens X-1, Y-1 and Z-1 are so-called high speed types; X-2 and Z-2, so-called medium speed types; and X-3, Y-2 and Z-3, so-called detail or high definition types. The relative intensification factors of these screens can be computed for any particular film and quality of radiation from the information provided in Figures 2, 4 and 6.

It will be apparent from the forms of the curves in Figures 4 and 6 that the standard

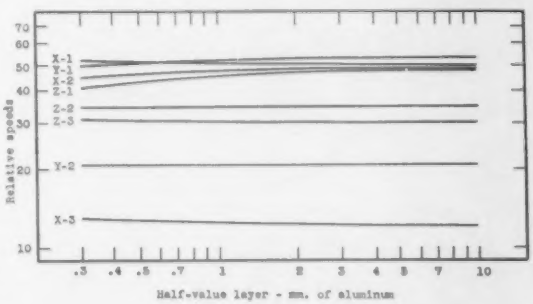

Fig. 7. Relative speeds of the same film-screen combinations represented in Figure 6. Radiation detector: 929 phototube Eastman front type ultra-speed intensifying screen and an aluminum filter, 0.5 mm. in thickness. The constancy of the various film speeds indicates that this system is an ideal detector for roentgenographic exposure meter service when films are to be exposed with intensifying screens.

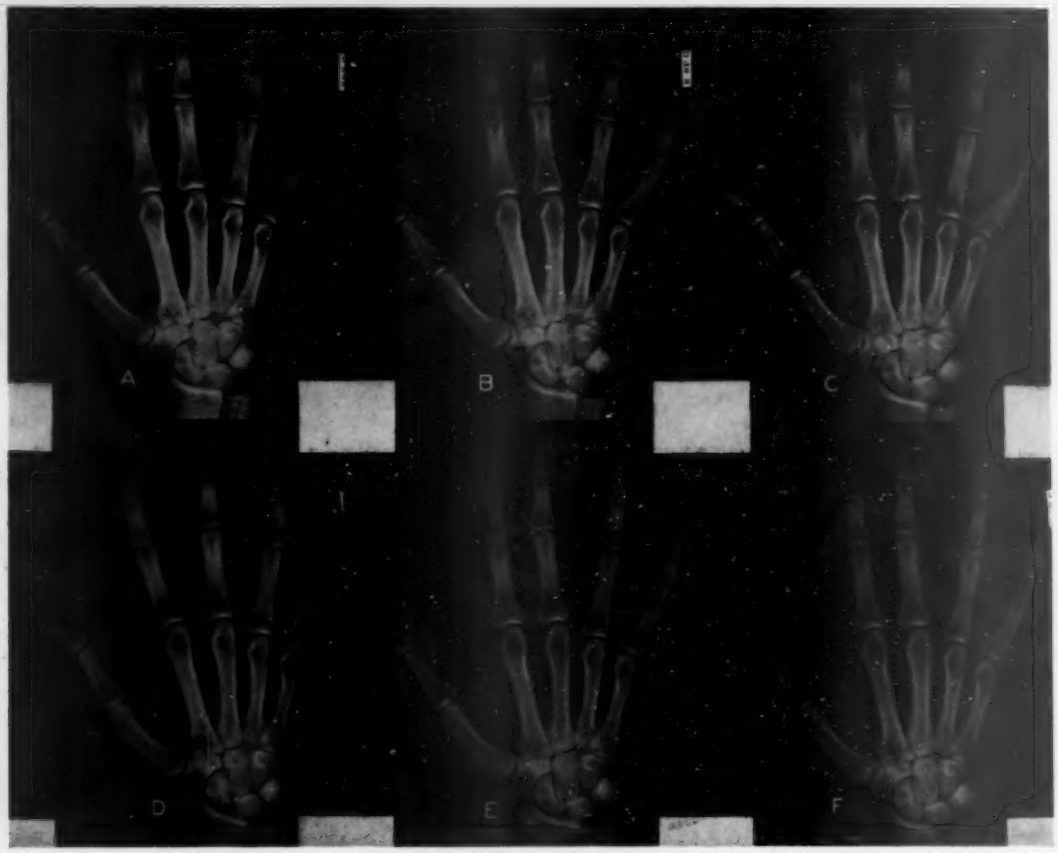

Fig. 8. Reproductions of six roentgenograms of the hand exposed without intensifying screens. Technical factors: *A*, 30 kv. (peak), 530 ma-sec.; *B*, 40 kv. (peak), 250 ma-sec.; *C*, 50 kv. (peak), 130 ma-sec.; *D*, 60 kv. (peak), 75 ma-sec.; *E*, 70 kv. (peak), 56 ma-sec.; *F*, 80 kv.(peak), 41 ma-sec. The exposures given the various films were calculated from measurements made with an exposure meter in which the radiation detector comprised a 929 phototube and a fluorazure screen. The close similarity of the average densities of the various films clearly demonstrates that this instrument is independent of roentgen quality for films exposed without intensifying screens.

radiation detector does not adequately satisfy the second criterion when films are to be exposed *with intensifying screens*, due to its excessive response to radiation of long wave length. However, this can be corrected easily by incorporating into the detector an aluminum filter 0.5 mm. in thickness. The results of such an addition are shown in Figure 7 where curves representing the speed factors of the same film-screen combinations presented in Figure 6 have been plotted. It will be observed that the various factors now are maintained within ±10 per cent of constant levels through the complete range of quality. Similar results can be obtained with radiation detectors employing a type "B" fluoroscopic screen or any front type calcium tungstate intensifying screen since, as it has been pointed out, the responses of these materials parallel that of the screen used in the standard radiation detector. In fact the type "B" screen is probably the most suitable one for use in actual roentgenographic practice since it exhibits the greatest sensitivity.

It can be concluded readily from an inspection of Curve 9 of Figure 1 that the ionization chamber is not a satisfactory radiation detector for exposure meters when

films are to be exposed with intensifying screens. Its performance can be improved by the use of relatively large amounts of filtration but such a procedure reduces the response of the device to inconveniently low levels.

From the findings presented in the foregoing paragraphs certain definite conclusions can be drawn regarding the design of radiation detectors for service in roentgenographic exposure meters:

1. Phototube-screen combinations unquestionably are more suitable than ionization chambers.

2. The most satisfactory combination when films are to be exposed *with roentgen rays directly* is that in which a fluorazure screen is employed.

3. When films are to be exposed *with intensifying screens*, the ideal radiation detector comprises an aluminum filter 0.5 mm. in thickness, a type "B" fluoroscopic screen and an R.C.A. 929 phototube. Such a system provides high sensitivity and a re-

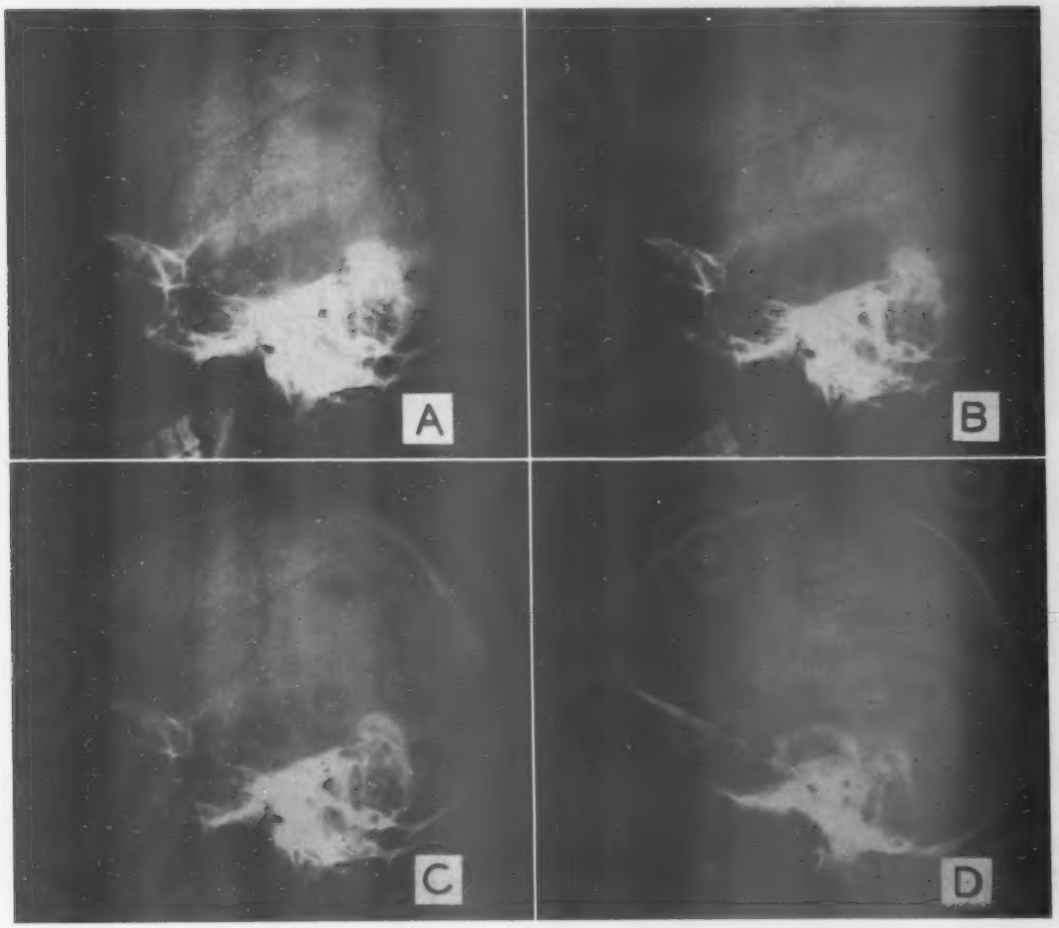

Fig. 9. Reproduction of four roentgenograms of the left lateral projection of the skull exposed through a Potter-Bucky grid with so-called hi-definition intensifying screens. Technical factors: *A*, 50 kv. (peak), 400 ma-sec.; *B*, 60 kv. (peak), 210 ma-sec.; *C*, 70 kv. (peak), 105 ma-sec.; *D*, 80.kv. (peak), 52 ma-sec. The exposures given the various films were calculated from measurements made with an exposure meter in which the radiation detector comprised a 929 phototube, a type "B" fluoroscopic screen and an aluminum filter, 0.5 mm. in thickness. It is apparent that this instrument is independent of roentgen quality for films exposed with intensifying screens.

sponse that parallels that of every film-screen combination that is commercially available through the complete range of radiation quality used in medical roentgenography.

That these conclusions are valid under actual roentgenographic conditions is well shown in Figures 8 and 9. In the first illustration a series of six roentgenograms of the hand exposed without intensifying screens is reproduced. Exposures were made with the roentgen tube operating at 30 ma. and with potentials ranging from 30 to 80 kv. (peak); exposure times were determined from measurements made with an exposure meter in which the radiation detector comprised a 929 phototube and a fluorazure screen. The roentgenograms of the skull reproduced in Figure 9 were taken with so-called high definition intensifying screens and exposed with the roentgen tube operating at 30 ma. and with potentials ranging from 50 to 80 kv. (peak); in this series, exposure times were determined from measurements made with an exposure meter in which the radiation detector comprised a 929 phototube, a type "B" fluoroscopic screen and an aluminum filter, 0.5 mm. in thickness. All films were processed under identical conditions. Although each film in both series was exposed to radiation of different intensity and quality, it will be observed that the various exposures did not differ appreciably from one another; that is, the average density of the diagnostic portion of any one film is essentially the same as that of any other. Densitometric measurements of the roentgenograms have confirmed this observation.

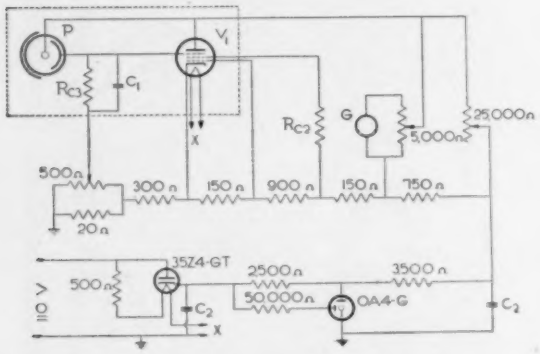

FIG. 10. Schematic diagram of amplifier circuit: P, phototube; V_1, 954 pentode; R_{C1}, 10^{10} ohm resistor; R_{C2}, 1,500 ohm resistor; C_1, 50 micromicrofarad condenser; C_2, 16 microfarad condensers; G, 0–100 microammeter.

II. AMPLIFIER DESIGN

The chief objection to the use of exposure meters in roentgenography is the necessity of taking two exposures (one for making the exposure meter reading and one for exposing the film) for every film made. The objection is especially pertinent where rotating anode tubes are used. This difficulty may be effectively overcome by increasing the sensitivity of the exposure meter to the point where it is unnecessary to take readings with the roentgen machine operating at its full capacity but instead at reduced current consumption. Under this condition, measurements can be taken without reducing tube life.

The sensitivity of an exposure meter is dependent to a large extent on the design of its vacuum tube amplifier circuit.* In an exposure meter recently described[3] a single stage, balanced triode amplifier was utilized. The sensitivity of this system, however, is insufficient to permit the satisfactory operation of the instrument when roentgen machines are operated at low milliamperage.

A more satisfactory amplifier circuit for exposure meter service is that shown schematically in Figure 10. Investigations indicate that this amplifier has a current sensitivity several times greater than that of the twin triode system to which reference has just been made and, if necessary, can be increased many times more simply by increasing the value of the resistor, R_{C1}. In addition, the amplifier is unusually stable and linearity is maintained through a range

* The recent development of an inexpensive, stable and extremely sensitive phototube of the multiplier type makes possible the design of exposure meters in which vacuum tube amplification is not required. This tube, the R.C.A. 931, will not be generally available, however, until after the conclusion of the national emergency.

of control grid potentials of approximately 2.0 volts. The circuit is a single stage, single tube type employing the R.C.A. 954 pentode, V_1. This vacuum tube is extremely small and can be mounted advantageously within the phototube case of an exposure meter to reduce the length of the leads in the control grid circuit.

The relatively great sensitivity of the amplifier can be attributed to the high control grid impedance of the pentode, V_1, when operated under the conditions outlined in Table I. This may be more fully appreciated when it is pointed out that one of the most important factors limiting the sensitivity of an amplifier is the magnitude of the grid impedance of the amplifier tube. In general, the current sensitivity of an amplifier is proportional to the external resistance (R_{C3} in Fig. 8) of the control grid circuit. However, the control grid impedances of vacuum tubes are characteristically negative and it can be easily shown that amplifiers become unstable when the resistance of the grid circuit approaches numerically the value of the control grid impedance. In fact, the maximum resistance that can be safely used without loss of stability is approximately 10 per cent of the grid impedance. The grid impedances of most commercial vacuum tubes operated under normal conditions range from -10^8 to -10^{10} ohms. It is well known, however, that by reducing the potentials applied to the various electrodes of an amplifier tube and by employing a tube of the pentode type in which the number 3 grid is used as the control element, the factors that tend to lower control grid impedance are reduced to a minimum. Thus the grid impedance of the pentode, V_1, approaches a value of -10^{13} ohms when operated under conditions recommended in Table I and the resistor, R_{C3}, accordingly can have an extremely high value.

TABLE I

TYPICAL OPERATION OF R.C.A. 954 PENTODE IN HIGH GRID RESISTANCE CIRCUITS

Filament voltage	6.3		6.3	volts
Plate voltage	13.5		13.5	volts
Grid No. 1 voltage	1.5		3.0	volts
Grid No. 2 voltage	9.0		12.0	volts
Grid No. 3 voltage	−4.5		−4.5	volts
Plate current	0.55		0.60	ma.
Grid No. 1 current	1.1		2.4	ma.
Grid No. 2 current	1.8		3.9	ma.
Grid No. 3 current	10^{-11}	to	10^{-12}	amp.
Plate resistance (approx.)	7,000		5,500	ohms
Grid No. 3 impedance	-10^{12}	to	-10^{13}	ohms
Transconductance	450		800	umhos
Grid No. 2 series resistor (stabilizing resistor)	1,500		800	ohms

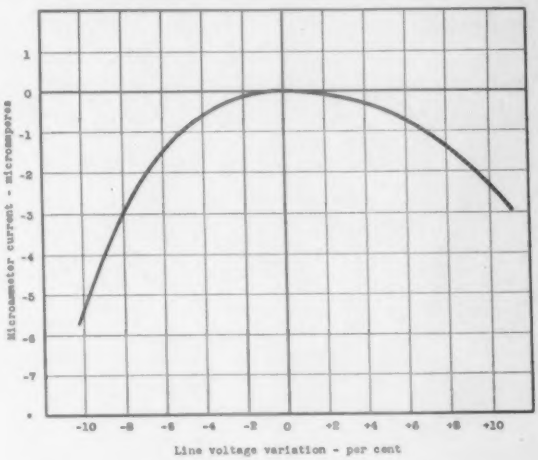

FIG. 11. Stability characteristics of amplifier.

Usually when a vacuum tube is operated at reduced potentials its transconductance is relatively low. This has been prevented in the circuit under discussion by operating the number 1 grid of V_1 at a positive potential of 1.5 volts. As a result, the pentode's transconductance approaches those of tubes operated at conventional voltages. The transconductance may be further increased by raising the potential of the number 1 grid to 3.0 volts. This, however, introduces some loss in amplifier stability.

The amplifier is stablized against fluctuations in line voltage by the gas triode, OA4-G, and the resistor, R_{C2}. The former regulates the plate and grid potentials and the latter stabilizes the circuit against fluctuations in filament voltage. The stability characteristics of the amplifier are shown in Figure 11 where microammeter current is

plotted against percentage change in line voltage. The curve compares very favorably with those of several circuits reviewed by Penick.[4] This circuit, however, provides a higher sensitivity and in addition requires no critical adjustments to insure its stability in most cases.

SUMMARY

Some of the fundamental problems involved in the design of roentgenographic exposure meters have been studied. In the investigation the characteristics of several radiation detectors were examined and the most suitable types determined. A vacuum tube amplifier circuit that is well adapted to exposure meter service also is described.

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Vol. 48, No. 1

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: Lawrence Reynolds, M.D. *Assistant Editor:* Ruth Bigelow, B.S.

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Publisher: Charles C Thomas, 220 East Monroe St., Springfield, Illinois.

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 220 E. Monroe St., Springfield, Ill. Information of interest to all readers will be found on page iv.

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Twenty-eighth Annual Meeting: 1943, to be announced.

EDITORIALS

THE VALUE OF RADIATION IN WAR KELOIDS

THE radiation therapy of keloid is nearly as old as the science of radiology. During the very earliest days of roentgen treatment of lupus vulgaris, it was noted that thick bands of scar which so often accompanied this lesion also regressed from the same type of treatment. Since then, a wealth of publications has accumulated on the subject and it seemed that all possible phases of technical application as well as medical indication had been exhausted. Although as a result of these investigations some differences continued to exist concerning the details of administering the irradiation, in general there was good agreement on its superiority over any other method used for the treatment of keloid. The opinion prevailed that even plastic surgery, to be entirely successful, must rely in the majority of instances on the added beneficial effect of the roentgen or radium rays.

It remained, nevertheless, for the present war with its severe and tremendously disfiguring injuries to furnish the real test. As may be surmised, attention was directed in the beginning mainly to the destruction or removal of fully developed keloids, but as time progressed it appeared more expedient to concentrate on preventing, if possible, the formation of such tissues. This led to a whole series of prophylactic measures.

According to Levitt and Gillies,[1] two distinguished British investigators, who made a most comprehensive study on the effect of radiation therapy on war keloids, the larger number of injuries of modern warfare fall in two categories: multiple small splinter injuries due to high explosive, and massive keloidal scarring following burns and scalds. The scars resulting in the first group are not much different from those of the last war, except for their great multiplicity and the fact that often they contain small foreign bodies which are impossible or too tedious of removal. As a result, they often appear quite thick and nodular, although because of the relatively small size they seldom produce functional limitations. If the scars lead to visible cosmetic disfigurement, they are treated according to the rules accepted for the cases met in civilian life. Bailey[2] recently published a textbook on surgery of modern warfare, in which he describes in extenso varied methods for the plastic operation of such scars. He recommends that when there is the slightest tendency to keloidal thickening, roentgen or radium treatment should be given immediately and that, when keloid scars are excised, this treatment be given before and after operation.

By far the most important, however, is the second group because the keloids following burns and scalds usually involve rather large surfaces of the body and often produce marked functional limitation. Furthermore, this type of injury under certain circumstances constitutes the greatest proportion of all war casualties, both in the services and among civilians. Good examples of the former are the severe burns of the hands and face in aviators or in gun crews of the Navy, and in the latter the burns from the flash of an exploding bomb or from fires started by incendiary bombs during the course of air raids. Before the outbreak of the present war the treatment of burns seemed fairly

[1] Levitt, Walter M., and Gillies, Harold. Radiotherapy in the prophylaxis and treatment of keloid. *Lancet*, April 11, 1942, *1*, 440–442.

[2] Bailey, Hamilton. Surgery of Modern Warfare. Vol. II. Williams and Wilkins Co., Baltimore, p. 265.

well standardized. Coagulation methods were accepted almost universally because of the fall in mortality rate following their use and because they seemed based on sound principle. However, the injuries of Dunkirk taught the first different lesson. In a series of 70 cases observed by Cohen[3] severe scarring contractures developed in most deep burns. Similar observations were made by a number of investigators. The Bunyan[4] envelope method with electrolytic sodium hypochlorite irrigation was then introduced and this was followed by other irrigation methods. Still later, the local application of various sulfonamides was advocated, whereas at Oxford the immediate application of plaster has proved very advantageous. All of these methods aim at one goal, to obtain a minimal scar with as little functional disability as possible.

A further step in this direction is the contribution of Levitt and Gillies who recommend that radiation therapy be used in connection with all war wounds in which there is a tendency to keloid formation. These authors have employed high voltage roentgen therapy also in a certain number of cases of deep scarring and contractures without typical keloid and obtained some encouraging results.

Based on wide experience with the irradiation of fully developed keloids, Levitt and Gillies since 1930 have gradually evolved a technique which also helps in preventing the occurrence of keloidal tissue. For this purpose they administer before an operation a dose of radiation which is strictly limited to the proposed line of incision, perform the operation during the time of radiation reaction and give an additional dose of radiation in the period following the operation. The ideal thing would be to give one single preoperative and one single postoperative radiation treatment, although this is not always found possible. If one has to rely on postoperative irradiation alone, this is carried out as soon as the stitches have been removed.

In the experience of Levitt and Gillies, of the fully developed keloids the red fleshy types do best, their radiosensitivity being almost in direct proportion to the degree of their exuberance. Even the thick "carapace" scars, which so often develop on the back of hands or on the face of aviators following severe burns or scalds, may give excellent results if treated with sufficient persistence over a long enough period. Only if no improvement is obtained within three months may the lesion be considered as radioresistant.

The more detailed technique of the method evolved by Levitt and Gillies, whether employed for prophylaxis or actual treatment of the keloid, entails the fact that the irradiation must be precisely localized with a lead foil window frame to the scar itself so that the normal skin remains well protected. The dose corresponds to a faint erythema on the face and to a fully developed skin reaction in other parts of the body. This latter amounts to about 1,500 r if the scar is linear or only few millimeters in diameter, 1,000 r if the scar is 1 cm. wide or 2 cm. in diameter and 800–1,000 r if the areas are larger. No difference in the dosage is made whether contact, medium or high voltage roentgen therapy is used, but the area exposed is limited to 100 cm.^{2} for medium voltage therapy (130–150 kv.) and to 50–75 cm.^{2} for high voltage therapy (200 kv.) except on the abdomen where these figures are halved. The treatment, which is given in one seance, is repeated within four to six weeks for two or three series. In very hard, thick scars several additional series may be administered but in facial scars three doses in one year constitute the maximum.

The immediate reaction consists in the appearance of a mild or fully developed erythema as specified. This is followed by resolution of the keloidal tissue extending over several months until complete resolution results. In very thick scar this process may continue for as long as eighteen

[3] Cohen, Sol. M. Experience in the treatment of war burns. *Brit. M. J.*, 1940, *2*, 251–254.

[4] Bunyan, John. The treatment of burns and wounds by the envelope method. *Brit. M. J.* 1941, *2*, 1–7.

months. The keloid ultimately is replaced by a white area which is usually of the same size as the original scar except that it is flat and decolorized. If there was limitation of function to begin with, this completely disappears. In many instances considerable motility of the affected joints is obtained.

These observations of Levitt and Gillies in connection with the regression of keloids find ample confirmation in other fields of radiation therapy. In postoperative mammary cancer, for example, the scar always appears smoother and softer when the mastectomy is followed by deep roentgen therapy than when no irradiation is undertaken. In a similar manner when the operation has led to the formation of thick keloid of the axilla with contracture of the arm as noted especially in colored people, the administration of three to four series of deep roentgen therapy with a technique similar to that described above often results in regression of the keloid with complete restoration of the function of the arm within about six months.

The importance of roentgen therapy in the after-treatment of extensive burns is emphasized also by Surgeon Rear Admiral Wakeley,[5] another distinguished British author, who, both in the last and present wars, made repeated valuable contributions on the subject. As a result of the experiences gained in the present war, he recommends the use of lanoline massage for a period of up to three months in all cases of extensive burns to prevent contractures and as soon as the slightest tendency to keloid is noted, roentgen therapy is instituted at once. So firmly is Wakeley convinced of the value of irradiation in keloids that he would see a roentgen therapy apparatus in every burn center not only for treating cases of keloid formation after healing of the burn but also for those cases in which extensive skin grafting has been performed and there is a danger of excessive formation of collagen between the grafts. By this procedure he was able to obtain excellent results even in cases which often were thought to be hopeless.

Taken as a whole, notable strides have been made since the outbreak of the present war in the treatment and prophylaxis of keloid. In burns and scalds the aim to avoid formation of keloidal tissues with late contractures has completely changed our prewar conception concerning the treatment of these injuries. In fact, the zeal to obtain the best cosmetic results with minimal interference has given rise to such non-conformity that there is danger that perspective is being lost. From this standpoint the creation of burn units, plastic centers, orthopedic sections, etc., represents a notable step toward creating order. In all, the contributory value of the roentgen therapy cannot be overestimated.

T. LEUCUTIA

[5] Wakeley, Cecil P. G. The late end-results of war burns. *Lancet*, April 4, 1942, *1*, 410–412.

HAROLD G. F. EDWARDS
1888-1942

DR. HAROLD G. F. EDWARDS died at his home in Shreveport, Louisiana, on May 2, 1942, after a short illness. Dr. Edwards was born on November 18, 1888, in Abbeville, Louisiana. He received his education at the Abbeville High School, Jefferson College and Tulane University, graduating from there in 1911.

Dr. Edwards served in the A.E.F. in World War I from 1917 to 1919 attaining the rank of captain. Following the war he studied at Bellevue Hospital, New York, and then became Radiologist to St. Johns Hospital in Lafayette, Louisiana.

In 1928 Dr. Edwards established an X-Ray and Radium Laboratory in Shreve-

port, Louisiana. For many years he served as Radiologist to the Shreveport Charity Hospital where he had unlimited material and worked untiringly. He was most interested in roentgen and radium therapy writing many authoritative articles among which might be mentioned:

"The Roentgen-Ray Treatment of Diseased Tonsils and Adenoids," 1935; "Modern Radiation Treatment of Tumors," 1935; "Tumors of the Mouth and Jaws," 1936; "Cancer of the Cervix," 1937; "Radiation Therapy in Benign Uterine Hemorrhage," 1937; "Interstitial use of Low Radium Content Monel Metal Needles in Treatment of Angiomas," 1938; "Carcinoma of the Cervix Uteri," 1941. He had just prepared a paper entitled "Radium and X-Ray Therapy in 378 Cases of Cancer of the Breast" to be read at the annual meeting of the Louisiana State Medical Society in New Orleans, April 29, 1942.

He was a member of the American Radium Society; American Roentgen Ray Society; Radiological Society of North America; American Association for Cancer Research; American Medical Association; Southern Medical Association; Louisiana State Medical Society; Shreveport Radiological Club, and a Fellow of the American College of Physicians. He was also a diplomate of the American Board of Radiology.

He was absorbed in his specialty and devoted his last few years to radiation therapy almost exclusively. His passing will be felt keenly by his colleagues, devoted patients and loyal friends.

C. P. Rutledge

ALFRED S. DOYLE
1876-1942

DR. ALFRED S. DOYLE, a member of the American Roentgen Ray Society since 1920, died at his home in Bywood, Pennsylvania, on May 1, 1942. Dr. Doyle was born in Scranton, Pennsylvania, in 1876. He was graduated from the Medico-Chirurgical Medical College of Philadelphia in 1914. He was for many years Radiologist to St. Agnes Hospital and was at one time President of its Staff. He was at one time Radiologist to St. Vincent's Hospital and was active in the affairs of the United States Public Health Service. His professional affiliations, in addition to the American Roentgen Ray Society, included the Philadelphia County Medical Society and the Philadelphia Roentgen Ray Society.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: Palmer House, Chicago, Ill., Sept. 15–18, 1942.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual meeting: 1943, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: 1943, to be announced.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Drake Hotel, Chicago, Ill., Nov. 30–Dec. 4, 1942.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N.Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. Warren W. Furey, 6844 S. Oglesby Ave., Chicago, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY
Secretary, Dr. P. E. Hiebert, 811 Huron Bldg., Kansas City, Kans. Meets third Thursday of each month at a place designated by the president.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in April.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. M. M. Pomeranz, 1020 Park Ave., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Annual meeting scheduled for Denver, summer of 1942, has been cancelled.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. L. W. Baird, Scott and White Clinic, Temple, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday each month, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress.
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
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Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

AMERICAN RADIUM SOCIETY

The Twenty-seventh Annual Meeting of the American Radium Society was held at Haddon Hall, Atlantic City, New Jersey, on June 8 and 9, 1942, under the Presidency of Dr. Hayes Martin, New York City. The meetings were held on the thirteenth floor of Haddon Hall in the Viking Room.

The scientific sessions were well attended and there was much interesting discussion following the papers. The complete program was published in the May issue of the JOURNAL and need not be repeated here.

On Monday afternoon at four o'clock the Janeway Lecture entitled "The Rôle of the Gynecologist in the Field of Cancer" was delivered by Dr. William P. Healy, Gynecological Surgeon, Memorial Hospital since 1921 and Associate professor of Obstetrics and Gynecology of the Cornell University Medical College. Dr. Healy is thus eminently fitted to speak on such a topic and his address made his listeners feel that the subject was covered in an adequate and authoritative manner.

On Monday evening the Annual Banquet was held in the Benjamin West Room at Haddon Hall. At the close of the dinner Dr. Hayes Martin, the President, made a few well chosen remarks and then introduced Dr. Douglas Quick, the Chairman of the Janeway Lecture Committee. Dr. Quick presented the Janeway Medal to Dr. Healy, who then responded by a very interesting talk giving personal reminiscences of Dr. Janeway with whom he had been personally associated.

The scientific sessions were resumed Tuesday morning and continued throughout the day.

The incoming President is Dr. William E. Costolow of Los Angeles who is at present a Commander in the United States Navy. The list of the other officers elected for the coming year will be published in an early issue of the JOURNAL.

AMERICAN COLLEGE OF RADIOLOGY

At the recent annual meeting of the American College of Radiology held at Haddon Hall, Atlantic City, on June 10, 1942, the following officers were elected for the ensuing year: President, Dr. B. R. Kirklin, Rochester, Minnesota; Vice-President, Dr. E. P. Pendergrass, Philadelphia, Pennsylvania; Treasurer, Dr. Hollis E. Potter, Chicago, Illinois (re-elected); Executive Secretary, Mac F. Cahal, Chicago, Illinois (re-elected); Board of Chancellors, Dr. J. C. Dickinson, Tampa, Florida, and Dr. W. W. Wasson, Denver, Colorado, for four year terms.

CLINICAL CONFERENCE OF MID-WESTERN RADIOLOGISTS

The 1943 meeting of the Clinical Conference of Mid-Western Radiologists originally scheduled for Chicago, has, at the invitation of the Cleveland Radiological Society, been transferred to Cleveland, Ohio. Dates and details will be announced later.

IMPORTANT NOTICE

Due to the fact that the Government has recently taken over Haddon Hall in Atlantic City where the Forty-third Annual Meeting of the American Roentgen Ray Society was to be held from October 6 to 9, 1942, it has become necessary to change the time and place of the meeting. Because of its central location, the Executive Council has decided to hold the meeting in Chicago, Illinois, at the Palmer House, on September 15, 16, 17 and 18, 1942.

H. Dabney Kerr
Secretary

Vol. 48, No. 1

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave.
Charleston, S. C.

ROENTGENOSCOPIC LOCALIZATION OF FOREIGN BODIES

By HENRY QUASTLER, M.D.*

From the Department of Radiology, New Rochelle Hospital
NEW ROCHELLE, NEW YORK

IF THE images of two points on a screen are observed while the tube is moved, the shift of the one which is farther from the observer will be greater than that of the nearer one. The parallactic deviation has been widely used to determine whether a foreign body is above or below a given landmark which might be a natural or an artificial one (lead pointer). This principle has proved especially useful in the method of extraction of foreign bodies under intermittent roentgenoscopic control.†

We have developed further the method of localizing a foreign body by observing the parallactic movements. In our modification two new features are added: (1) the results are quantitative, and (2) they are obtained automatically. This modification, however, can only be used on apparatus where screen and tube move together.

In the drawing below (Fig. 1) F marks the foreign body and L any landmark. X is the distance between foreign body and landmark measured vertically to the plane of the screen, and $\overline{TF}$ the distance between the foreign body and target measured in the same direction. If the target is in the position T_1 the projections F_1 and L_1 of foreign body and landmark, respectively, will appear at the same point on the screen. If the target is moved to T_2 the projection of the landmark will be shifted to L_2, but as we deal with apparatus where the screen moves with the tube, the total shift of the projection of the landmark in relation to the screen will be the sum of the distances $\overline{L_1L_2}$ plus $\overline{T_1T_2}$. This distance, the shift of the projection of the landmark in relation to the screen shall be called "the relative shift of the landmark" and designated by the symbol S_L. As a foreign body is (in this example) nearer to the target than the landmark, its projection is shifted still more to the point F_2. The distance $\overline{F_2L_2}$ is called the "differential shift of the foreign body" and designated by the letter D.

It can easily be deducted from the drawing that

$$\frac{X}{D}=\frac{S_L}{\overline{TF}}$$

hence the formula

$$X=D\cdot\frac{S_L}{\overline{TF}}$$

represents the relation between the foreign body-landmark distance on one side, and the differential shift of the foreign body, the relative shift of the landmark and the foreign body-target distance on the other.

According to the laws of parallactic movements, this relation remains true if the line uniting the target with the projections is not perpendicular to the screen, and also if the projections of foreign body and landmark do not cover each other in the first position of the target.

An arbitrary constant value can be ascribed to the relative shift of the landmark. The target-foreign body distance, of course, will vary from case to case. The

* At present: Carle Clinic, Urbana, Illinois.

† Ombrédanne, L., and Ledoux-Lebard, R. L'extraction des projectiles a l'aide du controle intermittent de l'écran. *J. de radiol. et d'électrol.*, 1916–1917, *2*, 65–78.

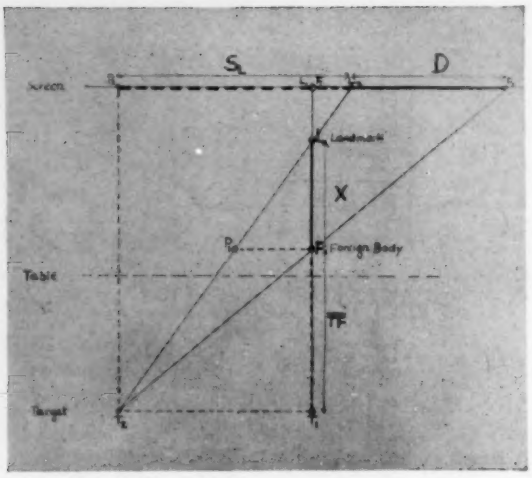

FIG. 1. *Roentgenoscopic localization of foreign bodies.* F designates the foreign body, L the landmark, F_1 and F_2, and L_1 and L_2, their projections on the screen in the positions T_1 and T_2 of the target of the roentgen tube. $\overline{TF}$ is the distance target-foreign body, X the distance foreign body-landmark. S_L is the shift of the image of the landmark in relation to the screen (which moves with the tube), and D the differential shift of the projection of the foreign body.

As the triangles T_2FP_1 and $T_2F_2L_2$ are similar,

$$(\overline{FP_1}):(\overline{TF})=(D):(\overline{T_2P_2}),$$

and as the triangles FP_1L and $T_2P_2L_2$ are similar,

$$(\overline{FP_1}):X=S_L:(\overline{T_2P_2}),$$

hence

$$(\overline{T_2P_2})\cdot(\overline{FP_1})=\overline{TF}\cdot D$$

and

$$(\overline{T_2P_2})\cdot(\overline{FP_1})=X\cdot S_L$$

therefore

$$\overline{TF}\cdot D=X\cdot S_L$$

or

$$X=D\cdot\frac{\overline{TF}}{S_L}$$

If, e.g., S_L is 12.5 cm., $\overline{TF}$ as assumed 50 cm., and a differential shift D of 0.5 cm. is measured, X is obtained from the formula: $X=0.5\cdot 50/12.5=2.0$ cm., which value can be directly read on the ruler (Fig. 2). If $\overline{TF}$ is as small as it can be, viz. 38 cm., the other factors being unchanged, X is 1.5 cm.; if $\overline{TF}$ assumes a maximum value, viz. 63 cm., X is 2.5 cm. These values do not differ considerably from the value of 2.0 cm. determined with the ruler.

distance between target and table is usually 38 cm. and this is the lowest value that can be given to the target-foreign body distance. Under ordinary conditions the foreign body will hardly ever be more than 25 cm. above the table top, thus 63 cm. is the maximum value of the target-foreign body distance. An arbitrary value of 50 cm. will always be near to the actual target-foreign body distance and therefore the distance between the foreign body and the landmark as calculated from the above formula will not differ considerably from the true value. If we calculate, for instance, that the distance between foreign body and the landmark is 2 cm., we may safely assume that it really is not below 1.5 cm. and not above 2.5 cm. This degree of exactness is usually enough for clinical purposes.

For the technical performance of the method of localization here described a set of two rulers has been designed. It is shown in the drawing (Fig. 2). On the small ruler only two edges are marked. The distance between the two edges (the length of the ruler) is the value arbitrarily ascribed to the shift of the landmark. This same length is repeated on the larger ruler: it is the distance between the left edge and the zero point of the scale. The scale itself gives the foreign body-landmark distance X corresponding to the value of the differential shift D. The scale is calculated as follows: S_L shall be set, for instance, at 12.5 cm. $\overline{TF}$ is about 50 cm., hence $S_L/\overline{TF}$ equals $\frac{1}{4}$, and X equals $\frac{1}{4}$ of D. Therefore, the distance between the foreign body and the landmark is reduced to $\frac{1}{4}$ of its value on the scale. This is the scale we use. If a higher value is chosen for the relative shift of the landmark the scale becomes larger and accordingly more accurate. If S_L, for instance, is 25 cm., the scale will show the distance in half its natural size but this lengthening of the scale makes the rulers somewhat cumbersome. If the foreign body is nearer to the target, thus below the landmark, its shift will be greater than that of the landmark and its projection will appear in the right hand half of the scale. This part accordingly is marked "below." If the foreign body is nearer to the screen than the landmark its projection will appear on the

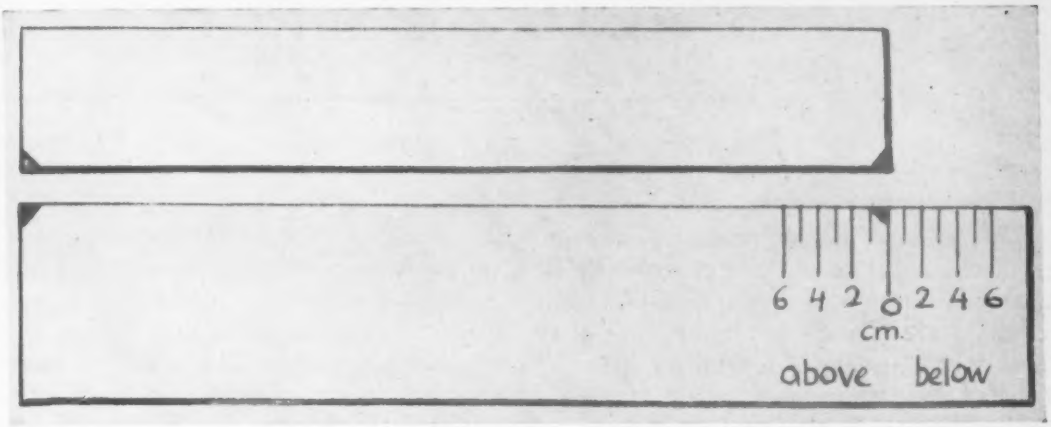

Fig. 2. *Rulers for roentgenoscopic localization.* To obtain the rulers, copy the drawing on transparent material (in the original measures or twice as large) and cut them out.

left hand of the scale marked "above."*

To localize a foreign body, one proceeds as follows:

(1) Choose a landmark which may be a natural (skeletal, etc.) or an artificial one (radiopaque mark on the skin, or the point of a surgical instrument). Put the left hand edge of the small ruler on the image of the landmark on the screen.

(2) Put the left hand edge of the larger ruler on the image of the foreign body on the screen in such a way that the rulers touch each other with their marked, long sides.

(3) Shift the tube-screen unit until the image of the landmark moves to the right edge of the small ruler.

(4) During this shift the image of the foreign body will have been shifted also. It will appear somewhere on the scale of the large ruler. Read the value of this point on the scale; it is the distance between the foreign body and the landmark.

Where it is possible the projection of the foreign body and the landmark should cover each other in the first position of the tube. This can usually be accomplished by shifting either the landmark or the tube. In this case the small ruler becomes superfluous; the left edge of the large ruler is put on the point on the screen where the images of the foreign body and the landmark appear. Then the screen-tube unit is moved until the image of the landmark is shifted to the zero point of the scale, and the distance between the foreign body and the landmark is read as usual.

Both disadvantages and advantages of this method are evident. The chief disadvantage is the inaccuracy which comes from two sources: (1) deviations of the target-foreign body distance from the assumed value of 50 cm., (2) errors in roentgenoscopic observation, such as putting the edge of the ruler slightly beside instead of exactly on the image of the foreign body or the landmark, which then become four times enlarged on the scale we use. The main advantages are that (1) the localization can be performed in a very few seconds, (2) no previous calibration or adaptation of the apparatus, or special training of the roentgenologist for this method, is necessary, and (3) any natural or artificial landmark can be used.

* To obtain the measures in inches make the length of the small ruler 5 inches and draw the scale (in inches) in ¼ of the natural size (¼ inch of the scale corresponding to 1 inch between foreign body and landmark).

A NEW TYPE OF HANGER FOR SUPPORT OF LEAD RUBBER PROTECTIVE APRONS

By ROBERT TAYLOR*
United Aircraft Corporation
EAST HARTFORD, CONNECTICUT

LEAD rubber aprons made for protection of the roentgenoscopist can usually be purchased in any one of the three different weights ranging from a 5 pound apron to one of 7 or 14 pounds, depending upon the degree of proection deemed adequate.

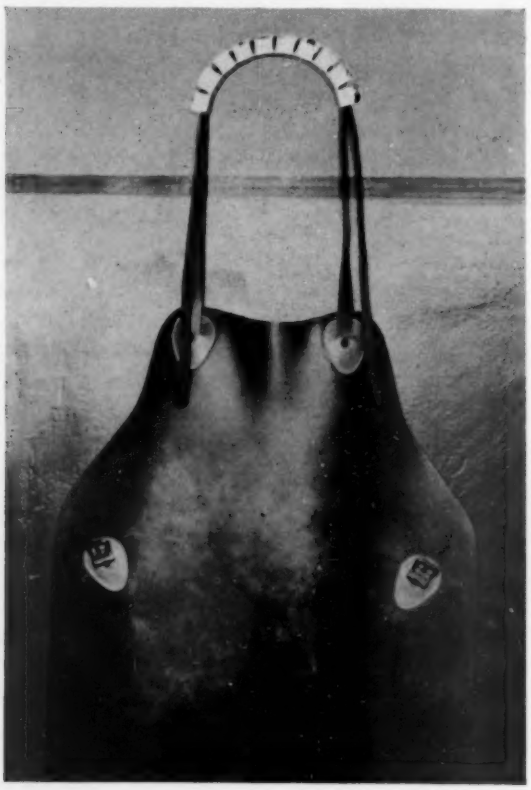

FIG. 1. Photograph of apron hanging on wall.

The average apron is made of 1/16 inch lead rubber which offers protection equivalent to 0.5 mm. of lead.

Damage to these aprons may be caused by any one or all of the following reasons: (*a*) thoughtlessly laying them down with the weight unequally distributed causing wrinkles in the lead rubber which eventually results in cracks with resultant loss of the aprons' protective value; (*b*) hanging them in a manner in which the weight is unequally distributed causing folds in the apron later leading to cracks; (*c*) hanging them on fragile or weak hangers which are unable to withstand the weight pull of the apron resulting in its falling to the floor. This usually means a ruined apron; (*d*) hanging them on hooks which allow the aprons to fold resulting in cracks within the apron.

The cost of these aprons ranges from ten to twenty dollars and it was felt a suitable type of hanger should be constructed to support them.

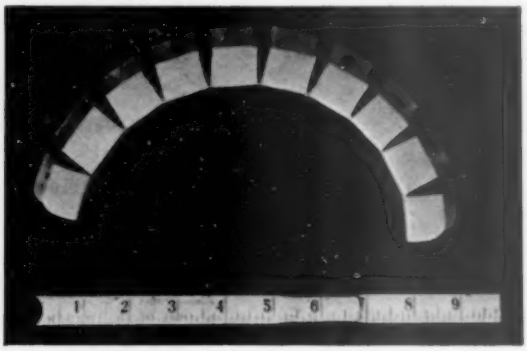

FIG. 2. Photograph of hanger.

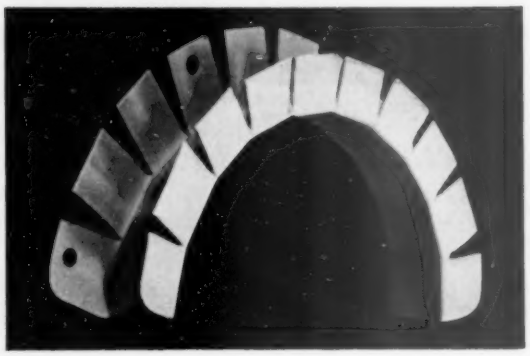

FIG. 3. Photograph of hanger (side view).

* Chief X-Ray Technician, Medical Dept.

The material used to construct the hanger was No. 18 gauge Allegheny steel of approximately 1/16 inch in thickness. Four holes for fastening the hanger are distributed equal distances apart in order to place the same degree of strain on one support as another. It may be secured to the wall with either screws or toggle bolts and, owing to the equal distribution of support in its rear, will not pull away from the wall and may be fastened to plaster walls without causing undue damage such as cracking or chipping the plaster.

The weight of the device is 7½ ounces and its supporting strength may be compared to the apron which it supports and whose weight ranges from 5 to 14 pounds.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

ALLEN, E. PETER. Pineal localization: a rapid direct method. *Brit. J. Radiol.*, March, 1940, *13*, 102–104.

Displacement of the calcified pineal gland is often the only evidence of an intracranial lesion that occupies space in the skull. There is no difficulty in locating such displacements on the fronto-occipital view but it is difficult to check them on the lateral roentgenogram. The author suggests a method of accomplishing this by the use of a modified Vastine and Kinney chart. It is easy to construct the chart, it is simple and the results are reliable. The chart and the method of its application are shown by diagrams.—*Audrey G. Morgan.*

SCHÜLLER, A. Radiography of the sub-arachnoid cisternae at the base of the brain. *Brit. J. Radiol.*, April, 1940, *13*, 127–129.

A method of filling the basilar cisternae with concentrated lipiodol (40 per cent) is described. The oil is injected by lumbar puncture and passed into the skull by inclining the patient, head downward, on a tilting table. This method shows the cisternae better than the method of injecting air or that of ascending lipiodol. It even permits of fluoroscopic examination. It does not cause any unpleasant symptoms or complications as the ascending lipiodol method may do.

Roentgenograms are given showing the shape, size and location of the normal cisternae at the base of the brain, particularly the lateral pontine cisterna and the chiasmatic cisterna with all the recesses inside the middle and anterior cranial fossae. These are the cisternae that are apt to be deformed or displaced by tumors at the base of the brain.—*Audrey G. Morgan.*

VOGT, E. C., and WYATT, G. M. Craniolacunia (Lückenschädel); report of 54 cases. *Radiology*, Feb., 1941, *36*, 147–153.

This study was undertaken in an effort to determine the relation of meningocele to craniolacunia. In approximately 6,000 consecutive skull examinations there were 120 patients with meningocele, and craniolacunia was present in 43 per cent of these 120 cases. Only 2 cases of craniolacunia occurred in the remaining group of skull examinations. Craniolacunia was least frequent in the presence of small meningoceles and more frequent in association with myelomeningocele than with simple meningocele. The presence of craniolacunia is an unfavorable prognostic sign in patients with meningocele.—*Wendell C. Hall.*

FREUND, MARGIT, and RIPPS, MAURICE L. Hand-Schüller-Christian disease; a case in which lymphadenopathy was a predominant feature. *Am. J. Dis. Child.*, April, 1941, *61*, 759–769.

Reports of cases of Hand-Schüller-Christian's disease are so numerous and the clinical symptoms characteristic of the malady so well known that the addition of another case to the literature seems to the authors to be justified only because it presented unusual clinical and pathologic features.

In their patient conspicuous lymphadenopathy as the first, and chief, symptom appeared at the early age of seven weeks. Typical osseous changes appeared at the age of thirteen months. While biopsy of the lymph nodes revealed histiocytic granulation tissue without cholesterol, at autopsy typical lipoid granulomas were observed. Since Rowland's report in 1928, the condition has been regarded by the majority of clinicians as an expression of a disturbance of cholesterol metabolism. On the contrary, pathologists, especially Letterer, have expressed the belief that the granulomatous lesion observed at biopsy and necropsy is specifically inflammatory and that "the cholesterol infiltration is by no means the cause of the granuloma formation but merely represents a characteristic associated feature of the granulomatosis." Letterer calls attention to the fact that a proliferation of reticulocytes and histiocytes initiates the granulomatous process and that only much later does the deposition of lipoid occur within the established granuloma. In the case reported in this paper, some areas of the lymph node showed a striking proliferation of re-

ticulum cells with giant cells, while others showed the same cells intermingled with lymphocytes, plasma cells and polymorphonuclear neutrophilic and eosinophilic leukocytes—actual granulation tissue. Lipoid deposits were absent, although infiltration of giant cells with neutral fat was found. The typical lipoid granuloma was observed only at autopsy. This observation is in full support, the authors believe, of Letterer's belief that the cholesterol is secondarily deposited within the granuloma and is not responsible for its formation.—*R. S. Bromer.*

Schüller, Arthur. Frontal cephalhaematoma. *Brit. J. Radiol.*, June, 1940, *13*, 218–219.

Cephalhematomas are generally traumatic injuries of the skull during labor. They occur most frequently on the right parietal bone, sometimes on the left parietal or occipital, but rarely on the frontal bone.

An unusual case of frontal cephalhematoma is described in a man of seventy-one with no symptoms except presbyopia. He had had the deformity since childhood. A profile roentgenogram showed a very marked thickening of the anterior half of the skull. A lateral view showed a large cavity inside the frontal bone. The enormous thickening of the anterior half of the skull was due partly to large air-containing sinuses but, for the most part, was represented by a large cavity which was not pneumatized. Inside the cavity there were different bone structures, nodules and ridges, spongy bone structures and a very unusual looking dense bone, forming hypertrophic walls of rudimentary sinuses.

Probably in early childhood a large traumatic hematoma raised the outer periosteum of the anterior half of the skull. The wall of the hematoma ossified, forming a cystic cavity. Different types of bone developed in the blood clot. No similar case has been described in the literature, probably because of the rarity of frontal hematoma.

In this case the bony walls of the sinuses developed without the formation of air-containing spaces. Apparently the nasal mucosa did not penetrate the frontal bone. This case supports the theory that the shape and size of the paranasal sinuses depend on the structure of the bone itself rather than on the activity of the mucosa. A similar theory is accepted by zoologists with regard to the pneumatization of the bones of birds.—*Audrey G. Morgan.*

Billing, L. Über die Deutung des röntgenographischen Übereinanderschiebens der Schädelknochen des Fötus. (Interpretation of the roentgen image of overlapping of the bones of the fetal skull.) *Acta radiol.*, 1941, *22*, 277–280.

Spalding's sign, or overlapping of the bones of the fetal skull has been considered a sign of death of the fetus if the overlapping was more than 2 cm. But the author shows from roentgenograms of a glass phantom of the fetal skull that such overlapping may be simulated by a mere difference in level of the bones. When the "glass bones" of the skull were shifted so that there was a difference in level this could be seen as such when the roentgenogram was taken in a line parallel to the sutures. But when taken in any other direction there appeared to be an overlapping. Even stereoscopic roentgenograms were not adequate to show the error. The roentgenogram of a fetal skull is shown in which there was apparently an overlapping of more than 2 cm. but a living child was born. There must have been only a shifting of level but the oblique roentgenogram simulated Spalding's sign.—*Audrey G. Morgan.*

Lysholm, Erik. Das Röntgenbild bei Tentoriummeningeom. (The roentgenogram in meningioma of the tentorium.) *Acta radiol.*, 1941, *22*, 303–317.

The author describes 4 cases of meningioma of the tentorium which he has seen since 1938. The first case was in a woman of fifty, who had had symptoms for about five months—dizziness, vomiting, headache on the left side, decreased vision, psychic disturbances and great emaciation. Ventriculography seemed to show a tumor of the right hemisphere of the cerebellum. Operation showed that it originated in the tentorium but had not penetrated it.

Case II was in a woman of forty-one who had had symptoms for about seven years. Operation showed a meningioma the size of a plum high up in the midline of the tentorium which had not grown through the tentorium; not diagnosed roentgenologically.

Case III was in a woman of thirty-one who had had symptoms for four months. Operation showed a tumor the size of an egg in the midline of the tentorium, a process of which the size of a hazelnut had grown through the fissure in the tentorium. The tumor had grown through both the tentorium and the falx, so that a diagnosis of its nature could be made before operation.

Case IV was in a man of forty-six. Ventriculography showed a dumbbell shaped tumor with processes on both sides of the tentorium with changes in the lateral ventricle and aqueduct as well as the fourth ventricle. Diagnosed roentgenologically.

The practical conclusion that the author draws from these cases is that in tumors that dislocate the occipital horn it is not sufficient to examine the lateral ventricle, but that the third and fourth ventricles also must be examined in order to make a diagnosis of the nature of the tumor.—*Audrey G. Morgan.*

LINDGREN, E. Roentgenological views on basilar impression. *Acta radiol.*, 1941, *22*, 297–302.

In basilar impression the floor of the posterior fossa of the skull around the foramen magnum is pushed upward toward the interior of the skull. This condition is also sometimes called flattening of the base of the skull. Martin's angles, used in anthropological research, have sometimes been used in studying it. These are not sufficient, however, as they give no information in regard to the condyloid regions of the occiput. In examination of this part of the skull the author takes a roentgenogram with the patient supine and the central ray at a cranial angle of 35°. This gives a good view of the foramen magnum and its lateral boundaries, showing the bulging of the condyloid regions which occurs in basilar impression. The earliest and most marked changes often occur in these regions.

In advanced cases the atlas is often hidden between the mastoid processes and it may be hard to distinguish it in a lateral roentgenogram. It is easier to get a clear view of the atlas in an oblique roentgenogram at about 20°. The atlas was seen in all of the author's 9 cases which are illustrated by roentgenograms. There were no malformations in the cervical spine in these cases.—*Audrey G. Morgan.*

COHEN, HARRY J., and KAY, MAURICE N. Associated facial hemangioma and intracranial lesion (Weber-Dimitri disease). *Am. J. Dis. Child.*, Sept., 1941, *62*, 606–612.

Cohen and Kay report a case of a ten year old Negro girl who had (1) a port wine nevus on the right side of the face; (2) calcification of the occipital lobe of the cerebrum on the same side as the nevus; (3) convulsive seizures involving the side opposite the cerebral lesion, and (4) visual disturbances. The syndrome of associated facial hemangioma and intracranial lesion (Weber-Dimitri's disease) is characterized by the presence of two outstanding signs: (1) a facial port wine nevus present at birth which follows the distribution of one or more branches of the fifth cranial nerve, and (2) calcification of the occipital lobe of the cerebrum on the same side as the nevus. The roentgenogram of the skull in the authors' patient showed a calcified area in the right occipital lobe, the group of double sinuous lines simulating the pattern of the gyriform surface of the brain. Corroborative evidence about the location of the lesion which caused the convulsive disorder was obtained from the electroencephalogram.—*R. S. Bromer.*

NECK AND CHEST

CRIMM, PAUL D., POTTS, WILLIAM L., and HUDSON, GWEN S. Tuberculin tests and roentgenograms. *Am. Rev. Tuberc.*, Aug., 1940, *42*, 203–208.

Among 1,000 subjects studied by roentgen examinations and tuberculin skin testings, 76.7 per cent showed evidence of tuberculosis; 21.4 per cent of these were negative to skin reaction; 23.2 per cent showed no roentgenographic evidence of pulmonary lesions.

Five hundred and fifty-three individuals were first tested with .00002 mg. P.P.D. intracutaneously; 429 of those negative to this test dosage were then given .001 mg. In 447, the injections were made bilaterally giving .00002 mg. in one arm and .001 mg. in the other, simultaneously (the latter being one-fifth the usual second dose or fifty times greater than the usual first dose). With the first method, 22.4 per cent were positive to the .00002 mg., while 38.2 per cent of the negatives were positive to the intermediate dose (.001 mg.); 51.9 per cent were positive to the combined tests. With the second group (i.e., simultaneously tested with the first and intermediate doses) 28.4 per cent were positive to the first strength while 59.5 per cent were positive to the intermediate dose.

In a previous study among children and teen ages it was found that the roentgen studies were more efficient than the tuberculin testings. Since in the present study the two compared closely, the authors "believe the x-ray is preferable." Moreover "the individual who has a positive tuberculin reaction should have an

x-ray examination to determine the extent and character of the infection—if pulmonary." On the other hand, apparently 21 per cent of those negative to roentgen studies may have lesions sufficient to produce positive allergy reactions.

Since there were only 2 positive cases among the entire group, the combination procedure was considered "expensive." For special groups, either procedure is considered valuable.—*A. A. de Lorimier.*

Hirsch, I. S. The utility of fluorography. *Radiology*, Jan., 1941, *36*, 1–11.

Soon after Roentgen's discovery attempts were made to photograph roentgen-ray shadows on a fluorescent screen by means of an ordinary camera, and present-day technique of fluorography is the result of a gradual development of the early methods. The great improvement in recent years in fluorescent screens, in photographic material, and in lens construction (especially in faster lenses) now makes routine application of fluorography practical. Until recent years there was no lens available which combined sufficient speed with adequately sharp coverage to the edges of the photographic film for satisfactory fluorographic work. The author uses a commercial 35 mm. film camera equipped with an f:1.5 lens. (The f number of a lens is the ratio between the effective diameter of the lens and its focal length. An f:1.5 lens is the fastest lens now generally available although lenses as fast as f:0.53 or even faster have been used in fluorography.)

The photographic film used for fluorography must be suited to the color of the fluorescent light of the screen used. Eastman and Agfa green-sensitive films give an excellent record of the Patterson "B" screen while Eastman special fluorographic film is best for the "Fluorazure" screen. Further research will be necessary to get a fluorescent screen more ideally suited to fluorography since present day screens which give best detail are lacking somewhat in brilliancy of illumination, and vice versa.

The author's apparatus for fluorography consists of a light proof box, pyramidal in shape, with a fluoroscopic screen at one end and a camera at the other end, 90 cm. from the screen. Accurate focusing of the camera should be done by trial exposure since the colored light of the screen will focus in a slightly different plane from ordinary daylight. Great care should be exercised to avoid scratches and dust particles. Exposure for fluorography is about twelve times more than for the same object when ordinary roentgenograms are made. For average chest work the factors are approximately 88 kv. (peak), 150 ma., and 1/10 sec. A single fluorographic chest film exposure subjects the skin to a dose of 0.4 r. For gastrointestinal examination the average case requires 96 kv. (peak), 80 ma., 4 sec. Due to the small size of the films they are best viewed by projection, the author projecting them to a magnification of 6.8 times. This is 15 per cent smaller than half size of the original screen image. A good projector and a grainless viewing screen should be used.

The chief advantage of fluorography lies in the simplicity of the method and in reduced costs. There is a saving in film, developer, filing space, and intensifying screens and cassettes. The advantages of fluorography in those cases where serial studies are necessary, in group examinations, etc., should be apparent. The method gives best results in the study of organs in which tissue contrast is naturally marked.

It is to be conceded that the fluorogram has not yet attained the clarity of contrast and sharpness of detail which characterizes the large film. If the fluorogram permits the determination as to whether or not a pathologic deviation exists, then it fulfills its purpose—and this it does; in fact, under certain conditions it depicts details with sufficient clarity to permit an accurate differential diagnosis. Fluorograms are more accurate than fluoroscopy in tuberculosis surveys and they can be read more rapidly than fluoroscopy can be done.—*Wendell C. Hall.*

Birkelo, C. C., and Brosius, W. L. Diagnostic difficulties in roentgen-ray examination of pulmonary tuberculosis. *Radiology*, Jan., 1941, *36*, 46–56.

A series of cases is presented in which the diagnosis of pulmonary tuberculosis was made on the basis of history, physical findings, and chest roentgenograms. Final studies on these cases showed that none of them had pulmonary tuberculosis. Cough, hemoptysis, thoracic pain, weight loss, night sweats, and fever were present in varying combinations and degrees in these cases. In this series of cases the following types of lung pathology were found in which the original diagnosis was pulmonary tuberculosis: bronchopneumonia, lung abscess, bronchiectasis, pulmonary cystic disease, primary cancer of the lung, metastatic cancer, silicosis, cardiac

disease, uncommon inflammatory diseases of the lung (moniliasis, actinomycosis, etc.), and even a case of syphilis of the lung.

The article demonstrates one fact—a roentgenogram of the chest may be diagnostic but there are many cases in which it is only one of the examinations which must be employed in making a diagnosis.—*Wendell C. Hall.*

Van Loon, Emily L., and Diamond, Sidney. Congenital absence of the right lung; its occurrence in healthy child. *Am. J. Dis. Child.*, Sept., 1941, *62*, 584–589.

The authors report a case of congenital absence of the right lung. Congenital absence of the lung is a rare occurrence and they could only find 40 genuine cases on record. Although most of the patients have been infants, the condition has been demonstrated in several adults of advanced age. No sex predilection is evident in the reported cases. The left lung has been the aplastic one slightly more often than the right. One instance of agenesis of both lungs in a fetus of eight months has been described.

The case reported is that of a girl, three and one-half years old, who presented unmistakable evidence of congenital absence of the right lung. The roentgenograms of the chest showed that the mediastinal contents were markedly displaced toward the right, the right dome of the diaphragm was obscured and no hilar markings were visible on the right side. In the lateral view, the trachea and heart were displaced posteriorly. Planigrams showed extension of the vascular markings from the left hilum across the midline into the right side of the chest and continuity of the air shadow in the right and left sides of the chest.

The case is regarded as one of true aplasia. At present there is no evidence that the child has any other anomaly than the absence of her right main stem bronchus and lung and narrowing of the lower end of her trachea. The prognosis for the patient appears to be good. Lack of respiratory reserve afforded by a normally functioning contralateral lung may prove an insurmountable handicap in the event that her left lung becomes extensively diseased, but, barring such an eventuality, there is no reason to believe that the child's future course will be adversely affected by the pulmonary aplasia.—*R. S. Bromer.*

Wolman, Irving J. Congenital stenosis of the trachea. *Am. J. Dis. Child.*, June, 1941, *61*, 1263–1271.

Congenital stenosis of the trachea is one of the most unusual anomalies of the respiratory tract. The lesion has received meager comment or no mention at all in the well known textbooks of otolaryngology and pediatrics, and the number of cases on record is small. The patient was an infant, aged two months. The roentgenographic examination showed an increased width of the mediastinal and cardiac shadows on the right side, as though retraction of the heart to the right were present. The possibility of atelectasis of the inner portion of the right upper lobe could not be excluded. The lungs were otherwise clear. In the lateral projection the trachea appeared to be narrowed throughout its length. At autopsy, a progressive narrowing of the lower segment of the trachea was found with complete absence of the membranous portion of the wall. The right upper lobe was completely collapsed and airless.

Clinical recognition, Wolman concludes, is difficult. The possibility of this rare anomaly should be kept in mind in the presence of symptoms of continuous or intermittent stridor with respiratory obstruction for which none of the usual causes can be established.—*R. S. Bromer*

Ramo, Leon, and Lustok, Mischa J. Angular roentgenography of the pulmonary apex. *Am. Rev. Tuberc.*, Dec., 1940, *42*, 738–746.

The authors contend that the routine 6 foot posteroanterior roentgenogram may be very disappointing insofar as its providing adequate visualization of the apices is concerned. Recourse to three procedures might be considered: stereoscopy, analyses of physical and laboratory findings, and special roentgenographic technique.

Routine practice of stereoscopy is considered extravagant. Physical examination alone cannot be relied upon.

Of 1,212 film studies (on 447 patients), 25 cases showed dubious conditions in the apices. The handling of these cases depended entirely upon the exact condition in the apices. A number of specialized roentgen procedures were considered: (1) a lateral projection with the arms positioned high; (2) exposures during forced expiration; (3) projection of the apices from below; (4) routine projections with the arms positioned upon the head, and (5) tomography.

Objections were found to each of these. Therefore, a special procedure was adopted. The patient was placed in the posteroanterior

position; the focal film distance was 36 inches; the exposure time, one-half that for the routine film. The tube was centered to the apex and then shifted downward for the uptilt or high for the downtilt. The advantages claimed include: clearance of the clavicles and magnification and separation of the first five ribs, anteriorly. Disadvantages include: uncertainty of an untried procedure and excessive distortion of structures at the bases plus masking of true retroclavicular lesions. However, this technique was considered informative in 23 of the 28 confusing cases.—*A. A. de Lorimier.*

Charr, Robert, Savacool, J. Woodrow, and Gordon, Burgess. Tuberculous cavities. *Am. Rev. Tuberc.*, Aug., 1940, *42*, 277–286.

Movement of the lungs varies in different parts of the thorax during respiration. As far as rib support is concerned, inspiration produces little movement of the posterior portions. This is particularly true when the patient is supine. The diaphragm produces greater movement of the posterior portions. These considerations have prompted the question as to whether tuberculous cavities located in the anterior portion of the lungs may have different prognostic significance as compared with those situated in the central or posterior portions.

One hundred and thirty-one cases were studied by lateral and stereoscopic serial roentgenography. Thirty-three were found to have cavitation in the anterior part of the lungs; 37, in the central and 61, in the posterior. In 19, the cavities were in the lower lobes (4, truly basal); 15, in the posterior portions; 2, in the central, and 2 in the anterior portions. One of the two with the anteriorly located cavities died; the other improved slightly following phrenic nerve operation. One of the two centrally located cavities improved while the other failed to do so. Ten of the 15 posteriorly located cavities improved (7 had phrenic nerve operation, artificial pneumothorax or both).

Seventy per cent of the cavities in the anterior portion were predominantly caseous and showed no evidence of healing. The majority of those in the middle or posterior thorax were principally fibrotic and showed considerable healing.

Large cavitations with fluid were common. Some of these showed evidence of enlargement following collapse therapy—likely due to bronchial stumps projecting into them, thereby producing a ball-valve effect.

In normal subjects, the motion of the posterior and central portions of the lower lobe appears to be from two to four times that of the anterior portion—the anterior portion moving from 0 to 1½ inches; the posterior, from 2½ to 4 inches. With abdominal support such as provided by phrenic nerve paralysis, the diaphragm ascends to an exaggerated expiratory position. However, anteriorly located cavities are not well collapsed thereby. Because the central diaphragm ascends vertically, centrally located cavities are better collapsed, as are also posteriorly located cavities.

Thus, with respect to treatment and prognosis, the anteroposterior location of cavities is important.—*A. A. de Lorimier.*

Bridge, Ezra. Case-finding with fluoroscopic roentgenography. *Am. Rev. Tuberc.*, Aug., 1940, *42*, 155–160.

Miniature film studies as used in photographing the fluoroscopic image are compared with standard 14″ by 17″ film studies. Single exposures were used for each of the two methods. Dual studies were thusly conducted on 450 men and 550 women—1,000 persons entering the dispensary of the Iola Sanatorium. Findings were classified as: (1) negative; (2) clinically insignificant (including apical caps, primary complexes, multiple nodulations, calcifications, parenchymal fibroses etc.); (3) suspicious; (4) clinically significant (minimal, moderately advanced and advanced tuberculosis and pleurisies), and (5) non-tuberculous.

In 952 of the cases there was agreement of interpretation by the two methods. In 48 of the cases there was some difference of consideration but in only 3 of these was the difference of any importance. Only 2 cases of significant tuberculosis were missed by the miniatures though 259 were recognized by them.

The miniature film method was found to be 50 per cent more expeditious than the large film method and with the consideration of 5,000 studies it is estimated that the miniature film provides for saving $2,700 (saving 83 per cent) and they reduce the necessary storage space 65 per cent.—*A. A. de Lorimier.*

Pinner, Max. Healing of tuberculous cavities. *Am. Rev. Tuberc.*, Dec., 1940, *42*, 731–737.

Auerbach has classified the process of healing of tuberculous cavities as: (1) healing by obliteration of the cavity lumen: (*a*) with scar formation and (*b*) with inspissation of caseous content, and (2) open healing.

Blocked cavities may re-open. A truly healed cavity becomes a scar, regardless of the mechanism concerned.

The author admits the error of a previous remark wherein he denied the probability that bronchial occlusion may produce closure. When secondary infection is not present, bronchial occlusion will not cause the toxic manifestations of sputum retention. Closure over a long period, under such conditions, is conducive to cavity obliteration. However, if secondary infection is present, a grave clinical complication results if the stem bronchus becomes occluded.

Two cases are described wherein cavity obliterations were studied. In one, the cavity was replaced by scar even though a patent bronchus was found to extend to the scar tissue. In the second case, the cavity had shrunk from a diameter of about 2.5 cm. to less than 0.5 cm. though a patent bronchus remained demonstrable. The morphology of the scar was identical with that of the first case except for the small residual cavity filled with bacilliferous material.—*A. A. de Lorimier.*

Auerbach, Oscar, and Green, Henry. The pathology of clinically healed tuberculous cavities. *Am. Rev. Tuberc.*, Dec., 1940, *42*, 707–730.

The authors have analyzed the pathology concerned with healing of tuberculous cavities. The criteria of healing included persistently negative sputum (though previously positive) and roentgenographic studies with serial evidence of involution of the cavities.

Two types of healing are generally considered: (*a*) closed healing, wherein the cavity is either replaced by a fibrous scar or the lumen is obliterated by retained caseation, and (*b*) open healing, wherein the involution takes place even though the lumen of a stem bronchus remains open.

Case descriptions are included to exemplify these changes.

Healing with inspissation of caseous contents appears to be the more common. The authors believe that in most instances obliteration of a cavity takes place after occlusion of its stem bronchus either by way of caseous material or by proliferation of endobronchial granulation. This situation may be aided by contraction of the cavity wall whereby narrowing and approximation of the bronchocavity junction occurs. Thus, collapse therapy aids by distortion of the course of the bronchi or by way of actual apposition of the bronchial walls. The thickness of the cavity walls, the amount of caseation, the vascularity of the walls and surrounding tissues all influence these changes.

In the closed type of healing there occurs a transformation of the cavity wall into fibrous tissue. When recovery is the end-result, granulation tissue invades the inner lining and obliteration of the cavity occurs by fusion of opposing layers.

When caseation fills the cavity lumen, there is developed a concentric zone of hyalinized connective tissues. In the open type of healing, caseation appeared to be absent from the wall. The specific tuberculous elements in the wall showed a gradual transition into fibrous tissues. Later, epithelialization occurred. This was considered to be true bacteriological healing.—*A. A. de Lorimier.*

Diamond, Sidney, and Durham, William R. Cystic lungs. *Am. Rev. Tuberc.*, June, 1940, *41*, 719–731.

Various terms have been applied to abnormal single or multiple pulmonary air sacs: cystic degeneration of the lungs, pulmonary pneumocysts, bullous emphysema, alveolar ectasia, lobular ectasia, cystic bronchiectasis, open honeycomb lung, pneumocele, pneumatocele, etc.

This condition is apparently not rare—more than 400 cases have been reported among 1,500 consecutive hospital admissions at the Veterans' Administrative Facilities at Legion, Texas, and Oteen, North Carolina. The authors have recognized 6 such.

As to etiology, various theories have been advanced: alveolar adenoma, inhibition of intrapulmonary ramifications of bronchi or alveoli, congenital bronchiectasis, agenesis of a portion of a lung, etc. Some cases appear to be congenital in development; others, acquired. Serial studies have indicated progressive developments of the condition following respiratory infections such as measles, whooping cough and pneumonia.

There is no special site of predilection for the defects. The sexes appear to be equally involved. The cysts may occur singly or they may be multiple; they may be unilocular or multilocular. Their size may vary from barely microscopical to giant size—perhaps occupying half of the chest. Structurally, they present the appearance of segregated sacculations having a minute connection with a bronchus. Their walls

may be lined with ciliated epithelium (as found in the walls of a bronchus) or they may be lined with cuboidal or squamous epithelium.

Roentgenographically, they may be discerned because of increased roentgenographic density—demarcated or not. The general structures of the thorax may be unchanged or they may be deviated—in case of compression of regional lung tissue, the deviations may be as found in atelectasis; with ballooning alone, the deviation may be the exact opposite. If there be a number of cysts close together, intervening septa may appear as either straight or curved lines, presenting the appearance of "honeycombing."

These lesions must be distinguished from a true pneumothorax, general or localized. Lateral film studies may be of value and serial studies are indicated. Accumulation of air in the case of a pneumothorax without bronchial communication will usually gradually disappear. Furthermore, in the case of a pneumothorax, the lung should be deviated toward the hilum.

Iodized oil can seldom be injected intrabronchially into cysts. The oil is interrupted in its flow in larger bronchial radicals. This feature should serve to distinguish the condition from typical bronchiectatic cavities.

There is no distinctive clinical picture. The condition is usually found during a routine physical or roentgen examination of the chest, and at any age.

Ten cases are reported; 4 of them were colored; the rest, white. Their ages varied from twenty-six to seventy. All had passed a rigid physical examination for duty with the Army. In 4, a single cyst was found. In 2, the left lung alone was involved; in 2, the right lung alone, while in 6, both lungs showed the lesions. Most were found either in the apex or the basal portions, though 4 occurred in the middle lung fields. Four of the patients (showing solitary cysts) had no symptoms whatever; 2 remarked of annoying dyspnea while 4 had gradually increasing dyspnea. Of these, 2 died and autopsy on one of them indicated the cystic disease to be the cause of death.—*A. A. de Lorimier.*

Addey, Walter. A case of pleural cyst. *Brit. J. Radiol.*, May, 1940, *13*, 180–182.

Simple cysts of the pleura are extremely rare. Apparently only 16 cases are on record. A case is described in a woman of forty-nine who was sent for roentgen examination of the heart on account of exhaustion, dyspnea and palpitation. She also occasionally had spasmodic attacks of pain in the precordium and in the back. There was no cough. She had had these symptoms for several years but they had grown worse recently.

Screen examination showed a small oval mass projecting from the heart border in the right cardiophrenic angle. It seemed to pulsate but it was hard to tell whether the pulsation was expansile or transmitted. Films showed the tumor close to the anterior wall of the chest and that it was producing an indentation of the lower ribs on the right side. The author first thought it was a tumor of the right middle lobe but roentgenograms after the injection of lipiodol showed the lungs and bronchi free. A possible diagnosis of chondroma was made and the patient kept under observation. After six weeks the tumor had increased slightly in size; after three weeks apparently no other change had occurred.

Operation showed that the tumor was a simple cyst projecting from the anterior layer of the pleura. The patient made an uneventful recovery and a year later roentgenograms showed no abnormality in the chest.—*Audrey G. Morgan.*

Pendergrass, Eugene P., and Young, Barton R. The roentgen diagnosis of neoplasms of the air and food passages, with particular reference to the larynx. *Radiology*, Feb., 1941, *36*, 197–211.

Formerly lateral views of the neck and careful roentgenoscopic examinations in the lateral and sagittal planes during phonation and swallowing were considered a complete roentgen examination. But it has now been found that a great deal of additional information can be obtained by roentgenograms in the sagittal plane with short target-film distance, and body-section roentgenography or planigraphy has proved invaluable in the roentgen visualization of the soft tissues of the larynx and adjacent structures in the sagittal plane and for the demonstration of both benign and malignant tumors in this region. Good body section roentgenograms can be obtained by simultaneous movement of the roentgen tube and Potter-Bucky diaphragm in opposite directions in a straight line. The tube and film move in horizontal planes which are, therefore, parallel to each other and to the plane of the body under examination. A lateral roentgenogram of the neck is first made and the depth of the lesion measured

before body section studies are made of the lesion and immediately above and below it to be certain that the whole of the lesion is shown.

Of course a knowledge of the normal anatomy of the region is a necessary preliminary to being able to make a diagnosis. Photographs of sections of the head and neck of a normal adult Negro are given and roentgenograms of tumors of the larynx.—*Audrey G. Morgan.*

Fleischner, Felix. Pathogenesis of bronchiectasis. *Am. Rev. Tuberc.*, Sept., 1940, *42*, 297–314.

Three cases of bronchiectasis are reported wherein the primary etiological factor appeared to be bronchial stenosis. The author theorizes that, because of this condition, secretions accumulate until they produce obstruction and atelectasis. Thereafter, emphysema results and possibly secondary infection with distortions of the bronchi and with the formation of cavities. Similar changes may be produced entirely upon the basis of intrabronchial infections such as bronchitis or bronchopneumonia.—*A. A. de Lorimier.*

Hamilton, Charles E., and Wexler, Nathan H. Carcinoma and tuberculosis of the lung. *Am. Rev. Tuberc.*, Sept., 1940, *42*, 334–342.

In 1932, Cooper was able to collect only 39 cases of pulmonary tuberculosis and primary carcinoma of the lung in the same individual. Since then, approximately 20 additional such cases have been reported. Some believe the coexistence of the two conditions to be purely accidental; some believe there is an actual "antagonism" toward the development of carcinoma upon tuberculosis, while a few such as Ewing, Wolf and Wilson, believe the exact opposite—that one condition predisposes to the development of the other.

The authors are reporting a case wherein the two lesions were found. This case was unusual in several particulars besides its having the two types of lesions. The tuberculous process was rapidly progressive. It was located in one lung while the carcinoma was located in the other. Marked osteoarthropathy was present during the earlier phases of the study but these changes practically disappeared toward the end even though the tuberculous process and the carcinoma progressed. This observation seemed to negate the toxic factor as well as the mechanical obstruction factor for explaining osteoarthropathy.—*A. A. de Lorimier.*

Waters, Theodore C. Medico-legal aspects of silicosis. *Am. Rev. Tuberc.*, June, 1940, *41*, 792–800.

The author is of the opinion that "industry has been prosecuted and plagued by common law suits" while "employees, on the other hand, should be compensated for disease injuries which they sustain as a result of their employment," and "common law procedure with jury trials is a thoroughly unsatisfactory method for the determination of this type of dispute."

Prior to Workmen's Compensation Laws, the employer was protected by defense such as (1) employees' assumption of risk; (2) employees' contributory negligence, and (3) negligence of employees' fellow associates.

Common law litigation has proved unsatisfactory because of its complexity, dilatory pleadings and delays and its high costs. Compensation acts have provided for inexpensive determination and prompt payment of benefits to the employee irrespective of negligence of the employer. At the same time, they have served to limit the amount of liability by the employer. These laws were originally intended to provide compensation for accidental or traumatic injuries—not for occupational disease injuries.

The author believes that Medical Boards are necessary for successful administration of occupational disease legislation, such as silicosis compensation laws. In addition to actually analyzing the cases, such a Board should be granted full power to examine claimants, during the time of pending claims and to conduct autopsies in case of death. "The most humble claimant should have his case heard and determined without the necessity of engaging professional witnesses." Heretofore, medical examiners and Medical Boards have served merely in an advisory position.

The Workmen's Compensation Laws provide an employee as an "accrued" or "potential" liability—thus making the employer an insurer of the health of the employee. The employer is interested in *how* the changes may have developed; the employee, merely as to the presence of the changes. Therefore, certain states have refused the application of laws for partial disabilities. Others have limited the financial obligation. The author proposes elimination of all partial disability rights until "some com-

petent and approved method of evaluating partial disability has been recognized."

Two court decisions are discussed—*A. A. de Lorimier.*

Friedlaender, George. Radiological and clinical study of aortic aneurysm. *Brit. J. Radiol.*, April, 1940, *13*, 109–122.

One of the serious late results of syphilis is disease of the blood vessels and the most serious complication of such vascular disease is aneurysm of the large vessels, particularly the aorta. It is estimated that aortic aneurysm develops in 10 to 20 per cent of cases of syphilitic aortitis, and it would probably be still more frequent if many of the patients did not die of the aortitis before aneurysm had time to develop.

The clinical symptoms are often slight in these cases and the best method of demonstrating aortic aneurysm is by roentgen examination. The roentgenogram also shows the location and size of the aneurysm.

Case histories are given of 18 cases of aortic aneurysm seen by the author and roentgenograms of some of the outstanding ones are given. Marked calcification of the aneurysm was seen in 4 cases. Two of these were cases which had come to a complete standstill. Calcification is evidently an attempt on the part of the body to put a stop to the growth of the aneurysm.

The prognosis of aortic aneurysm is very serious. Lewis estimates the life expectancy of a patient with syphilitic aortitis to be six years and that of the patient with aortic aneurysm four years if the patient is under full treatment and not at work. Other authors have given even shorter estimates. But among the author's patients two had had the aneurysm for fourteen and twenty years respectively and 7 out of the 18 were observed for more than five years after the first roentgen examination. Of course the time is still longer if it is calculated from the first beginning of clinical symptoms. In 4 of his cases (22 per cent) which were followed up for four to nine years, the aneurysm came practically to a standstill both clinically and roentgenologically. These aneurysms were small and they showed little evidence of widespread syphilitic aortitis. The patients continued to work after the diagnosis of aneurysm was made. Increase in the size of the aneurysm was not always accompanied by aggravation of the clinical symptoms.

There was aortic regurgitation in 7 of these cases. This complication does not seem to be more serious than in other forms of heart disease unless there is serious syphilitic aortitis. The syphilis of the aorta is more dangerous than the aneurysm itself. Not more than 10 to 20 per cent of the patients die from rupture of the aneurysm or its pressure on neighboring organs. The others die of coronary disease or congestive heart failure caused by the syphilitic aortitis rather than the aneurysm.

Antisyphilitic treatment was definitely harmful in one of these cases in which the syphilitic vascular disease was very widespread. In other cases antisyphilitic treatment seems to have little effect, but in some cases it slows down the growth of the aneurysm and definitely improves the general condition. It seems also to promote calcification of the vessel wall, which of course arrests the growth of the aneurysm. The effect of treatment seemed to be particularly good in cases in which the aneurysm was small, the aortitis not widespread and little or no treatment had been given previously.—*Audrey G. Morgan.*

Levene, George, and Lowman, Robert M. Roentgen localization of myocardial damage resulting from coronary artery disease. *Radiology*, Feb., 1941, *36*, 159–170.

Occlusion of the coronary arteries causes varying degrees of damage of the myocardium. The authors hold that roentgen demonstration of this injury compares very favorably with other methods of diagnosis. It shows as a rule localized changes in the left outline of the heart and localized decrease in the amplitude of the contractions. Illustrative roentgenograms and kymograms are given. They have found the ordinary roentgenogram more valuable in diagnosis than the kymogram. At the Massachusetts Memorial Hospitals they first take a frontal roentgenogram, then a right anterior oblique one and then a left anterior oblique. In this way infarcts from myocardial damage can be localized accurately.

The special value of roentgen diagnosis in this condition lies in the fact that diagnosis can be made earlier than by other methods. The history is unreliable as many of these patients do not have pain. In the early stages of coronary thrombosis the electrocardiogram may be

negative and certain drugs, including digitalis, may change the electrocardiogram to such an extent that coronary thrombosis cannot be recognized. Moreover, after an attack of coronary thrombosis the electrocardiogram may return to normal quickly while it takes at least six months for the roentgen signs to disappear. A table is given showing an analysis of 33 cases of coronary artery disease localized at autopsy. The autopsy findings were in complete agreement with the roentgen findings in 72.7 per cent of the cases and with the electrocardiographic diagnosis in 54.5 per cent.—*Audrey G. Morgan.*

ADDEY, WALTER. A case of congenital atresia of the oesophagus. *Brit. J. Radiol.*, May, 1940, *13*, 179.

A child thirteen days of age had vomited continuously since birth. Milk containing a little barium was given in a feeding bottle. The passage of the barium was stopped just above the upper piece of the sternum. On the film the shadow had a sharply defined rounded lower border with not a sign of even a trickle of barium below it. Its lower boundary was a little above the bifurcation of the trachea.

In spite of rectal feeding the child died fourteen days later and postmortem examination showed the atresia of the esophagus just as it had been shown on roentgen examination. There was no passage through the stricture and no communication with a bronchus or the trachea.

Notwithstanding the extreme rarity of congenital atresia of the esophagus, the physician who sent in this case had another exactly identical one three days later, though the child in this case was too ill for roentgen examination.—*Audrey G. Morgan.*

ABDOMEN

DWYER, MAURICE F., BLACKFORD, JOHN M., COLE, WILLIAM S., and WILLIAMS, ROBERT H. Peptic ulcer: a review of 1,033 cases and a follow-up study of the patients diagnosed between 10 and 20 years ago. *Radiology*, Feb., 1941, *36*, 217–223.

Some years ago the authors examined 3,000 patients with chronic dyspepsia and found that only 15 per cent of them had organic lesions of the stomach or duodenum. Of the organic lesions that cause chronic dyspepsia, ulcer of the duodenum is most frequent and it is second only to cholecystitis as a cause of stomach symptoms.

The clinical picture of duodenal ulcer was formerly considered very characteristic but it has been found that about 20 per cent of the cases diagnosed by roentgen examination do not show the classical clinical picture of the disease. Duodenal ulcer generally begins at an early age, the highest incidence being between twenty-one and thirty years of age.

The authors' findings are based on a study of 1,033 cases, 930 of duodenal ulcer and 103 of gastric ulcer. The earlier duodenal ulcer begins the more apt the patients are to show the classical picture of the disease. Stomach ulcers appear at a relatively later age than duodenal ulcers. Only 29 per cent of the authors' patients with stomach ulcer reported that their symptoms began before the age of thirty, while 53 per cent of the patients with duodenal ulcer had symptoms beginning at that early age. The symptoms of gastric ulcer are more severe than those of duodenal ulcer. Hemorrhage is frequent in both classes of cases. Of this group 208, or 19 per cent, had hemorrhage and this was the symptom that brought 113 of them for treatment. Massive hemorrhage from ulcer is more frequent before forty-five years of age than after but the great majority of deaths from this cause occur after forty-five. Many lives could be saved by prompt operation in cases of intestinal hemorrhage in patients over forty-five years of age.

A questionnaire was sent out to 141 patients treated for peptic ulcer from ten to twenty years ago, the average time being fourteen years. Among those who had been treated medically 65 per cent thought they had had 75 per cent or more relief and among those treated surgically 86 per cent thought they had been relieved to that extent.—*Audrey G. Morgan.*

WILLIAMS, E. ROHAN. Intussusception—a radiological study. *Brit. J. Radiol.*, Feb., 1940, *13*, 51–70.

The author holds that clinicians in England do not sufficiently appreciate the value of roentgen examination in intussusception. He has observed 15 cases since 1933 and presents a review of the subject illustrated by histories and roentgenograms of these cases.

An intussusception is made up of three concentric cylinders and the distribution of the barium in different types of invagination is discussed. In acute cases only the barium enema is used. In subacute and chronic cases com-

bined use of the barium meal and barium enema is to be preferred. In acute cases the barium enema is also a useful method of treatment. Of course it should not be used in advanced cases when there is toxemia or peritonitis but in other cases it may make operation unnecessary or if necessary may make it easier.—*Audrey G. Morgan.*

Ledoux-Lebard, R. Recent advances in the röntgen-diagnosis of gastric cancer. *Brit. J. Radiol.*, Feb., 1940, *13*, 37–50.

In this twenty-first Silvanus Thompson memorial lecture, the author discusses the case which first led him to select this subject for the lecture. Three years before he had made a roentgen examination of a patient on which he based a diagnosis of cancer of the stomach. The operating surgeon could not see or palpate any lesion of the stomach and said that his diagnosis was wrong. When the patient returned three years later the roentgen evidence of cancer was unmistakable. This and other cases of a similar nature show that many of the classical dicta in regard to cancer of the stomach are wrong. There are various forms of cancer of the stomach and they are not necessarily rapidly fatal nor do they all in the early stages cause emaciation, loss of appetite and pain. Some of them are long drawn out and early diagnosis by competent roentgen examination might save many lives.

In annular cancer of the pylorus one of the reasons for failure in diagnosis is lack of visual education, and this should be given to all students. Improved technique has made it possible to diagnose stomach ulcers better than formerly and to detect signs of beginnning malignant degeneration. It has been the classical teaching that an ulcer more than 3 cm. in diameter is almost always cancerous. But the decision should not be made on size alone but on the general appearance, shape, outline and irregularity of the niche and particularly its site. Ulcers of the vertical part of the lesser curvature rarely become cancerous; malignancy at this site is generally primary. On the contrary, ulcers of the horizontal part of the lesser curvature from the sulcus angularis to the pylorus very frequently undergo malignant degeneration. And it should be remembered that primary malignancy may occur not in the form of a tumor but in that of an ulcer or a simple infiltration. In the infiltrating form the roentgenogram frequently shows a step or depression of a small area of the wall which in the earliest stage is very hard to detect. The infiltrated part may look as if fitted into the wall. If such an image persists it should be regarded with great suspicion. Some large niches look like a step of triangular form; these are almost always due to primary malignancy though they are often still mistaken for simple ulcers. Perhaps the most typical image is that of the flat niche which may assume the patellar form.

While there is no one appearance that is pathognomonic, roentgenologists should be taught to be increasingly suspicious of slight signs of malignancy and serial roentgenograms should be taken and superimposed. In the interval a test treatment may be given. If the suspicious signs persist and the roentgenologist finally concludes that there is malignancy the surgeon should be willing to perform gastrectomy. Often when he can feel no abnormality at all microscopic examination will show malignancy. Occasionally an unnecessary gastrectomy may be performed but the danger is less than that of overlooking malignancy. Perhaps the only way to detect all cases would be systematic examination of the digestive tract of all persons above a certain age. Until that can be brought about the best that can be done is to teach the roentgenologist a high index of suspicion of cancer and skill in detecting and interpreting the earliest signs, and to teach the surgeon and general practitioner confidence in this method of early detection of cancer of the stomach.—*Audrey G. Morgan.*

Kelley, C. H., Lawlah, J. W., and Berry, L. H. Mucosal relief technic correlated with gastroscopy in 150 cases. *Radiology*, Jan., 1941, *36*, 77–85.

The gastric mucosal relief was studied by the roentgen ray in 150 cases and the findings in these cases were checked for accuracy by gastroscopy. A simple barium-water mixture was used, and in most cases only a single swallow was used. Gastric lesions demonstrated by the relief method include benign and malignant neoplasms, ulcers, and chronic gastritis. The last of these is most difficult to diagnose accurately and a diagnosis of chronic gastritis should be made with reservation. Gastroscopy in these cases was of value in giving a better understanding of normal mucosal patterns depicted by the relief method.—*Wendell C. Hall.*

CHONT, L. K. Sarcomas of the small intestine and reference to their radiosensitivity. *Radiology*, Jan., 1941, *36*, 86–97.

Eight tumors of the small intestine are reported: 3 leiomyomas, 1 leiomyosarcoma, 3 lymphosarcomas, and 1 carcinoma. Tumors of the small bowel are rare. They produce occult bleeding, abdominal pain, and sometimes a palpable tumor. A high percentage of such tumors can be diagnosed by a careful roentgen examination.

Leiomyosarcomas are very rare in the small bowel. Morphologically they are large, nodular, solid or cystic tumors, yellowish in color. Degeneration is a common finding in these tumors. They may occur as extrinsic or intrinsic polypoid growths. Metastases may be found in different organs such as the lung, liver, thyroid, pancreas, kidneys, suprarenals, gastric and intestinal mucosa, subcutaneous tissue, and bones. Judging from reports on radiation treatment of leiomyosarcoma in other ograns of the body, the author believes that these tumors are radiosensitive although there are no reports on the treatment of these tumors in the small intestine. Leiomyosarcomas occur most frequently in the jejunum.

Lymphosarcoma of the small bowel is much more common than leiomyosarcoma. The most common location of this tumor is the ileum. These tumors are very radiosensitive. They arise from the submucosa of the lymphatics and produce an intrinsic, extrinsic, or infiltrating lesion. The intestine proximal to the lesion is sometimes enormously dilated as a result of chronic incomplete obstruction. Perforation is rare. The age incidence is greatest between twenty-five and forty-five years with a relative high frequency in the first decade.

Both leiomyosarcomas and lymphosarcomas are more common in males than in females. The age incidence is quite wide in both types of tumor, but lymphosarcomas usually occur in younger individuals than leiomyosarcomas.—*Wendell C. Hall.*

LOFSTROM, J. E. Further observations on elimination of intestinal gas shadows in roentgenography. *Radiology*, Jan., 1941, *36*, 34–41.

The many advantages to be obtained from satisfactory elimination of gas and feces from the intestinal tract in abdominal examinations are enumerated. The author previously reported a group of cases in which pitressin was used to clear the intestinal tract of gas and feces, but he has used pitressin in an additional 1,000 cases since publication of that article. His routine for using pitressin is as follows:

Cleansing enema the night before the examination. This is followed by another cleansing enema in the morning about one and one-half hours before the time set for roentgenology. One hour before examination, 0.5 cc. (10 units) of pitressin is given intramuscularly and repeated in one-half hour. No cathartic is given. The roentgenograms should be made not more than thirty minutes after the last injection since a re-accumulation of gas in the bowel usually begins after this time. He feels that this method of eliminating intestinal gas is more successful than other methods. It is safe, economical, and certain in at least 90 per cent of cases.—*Wendell C. Hall.*

HADLEY, HENRY G. Non-rotation of colon. *Brit. J. Radiol.*, Jan., 1940, *13*, 35–36.

The clinical importance of non-rotation of the colon comes from the fact that appendicitis may develop on the left side and not be recognized before rupture. It is very unusual. It is an anomaly of development that occurs between the fifth and eleventh weeks of embryonic life. There seems to be a hereditary tendency in its occurrence which is illustrated by this report of 2 cases in a mother and daughter. The mother, aged fifty-seven, complained of chronic constipation. Roentgen examination showed the small intestine on the right side and the entire colon on the left side, the cecum and ascending colon being on the median side of the descending colon. The transverse colon was folded downward over the other portions and in front of them. This patient had two daughters, one of whom had the same anomaly in the position of the intestines while the other was normal.—*Audrey G. Morgan.*

ELITZAK, JACOB, and WIDERMAN, A. H. Nonspecific ulcerative colitis in childhood. *Am. J. Dis. Child.*, July 1941, *62*, 115–126.

Nonspecific ulcerative colitis is characterized by the appearance of bloody diarrhea, resulting from inflammatory changes in the large bowel, which can be ascribed to no definite cause. It is not generally appreciated that this condition occurs in childhood. The authors analyze data from 23 cases in which the disease was diagnosed as nonspecific ulcerative colitis. Of the 14 cases

in which the patient was observed in the follow-up service, there was complete healing in 5, improvement in 3, and slight or none in 6. The cause of the condition is still unknown. The symptoms are characteristic, and the pathologic picture is definite. The results of proctoscopic examination are typical. The roentgen examinations following barium enemas may show a normal colonic pattern early in the disease. During the later active stages the roentgenogram usually reveals marked mottling and feathering. During the later stage, a typical stiff pipe-like appearance will be seen. Relapses and recurrences are common, and the prognosis must be guarded. At present there is no specific successful form of treatment.—*R. S. Bromer.*

Kennedy, Roger L. J. Polyps of the rectum and colon in infants and in children. *Am. J. Dis. Child.*, Sept., 1941, *62*, 481–488.

Kennedy states that although it is true that the great majority of polyps of the rectum and colon are either adenomatous or adenocarcinomatous some are sarcomatous; others are fibrous, myxomatous, lipomatous, angiomatous or inflammatory. The term polyp as applied to lesions of the rectum and colon should therefore be considered as a general designation which applies to the form or the shape of the lesion rather than to its histologic or pathologic type. In the analysis of the 49 cases of polyps of the rectum or colon studied by him he found bleeding from the bowel was by far the most common symptom. The polyps were visualized by proctoscopic or roentgenologic methods. Large, pedunculated polyps are easily visualized but difficulty is encountered in the case of the smaller lesions, some of which may be only a few millimeters in diameter. The shape of the lesion, whether it is pedunculated or sessile, also determines to a great extent the ease of recognition. Small sessile polyps, although seen relatively easily through the proctoscope, may not be visualized by roentgenologic examination. Another difficulty which confronts the roentgenologist is the partial or total lack of cooperation on the part of the patient. Kennedy regards it as imperative, however, that roentgenologic examination be performed in every case in which proctoscopic examination has demonstrated the presence of a polyp in the rectum or colon of an infant or child. It is even more imperative in cases in which children have had unexplained bleeding from the bowel but proctoscopic examination had failed to reveal any abnormality.

Treatment in his series of cases was either by surgical methods or by removal or destruction of the polyp by means of the proctoscope. Some of the lesions found were frankly carcinomatous. All adenomatous polyps, except those found in certain cases of chronic ulcerative colitis, have carcinomatous potentialities and should therefore be removed or destroyed.

Roentgenologic examination was made in 32 of the 49 cases. In 15 cases polyps were found in the rectum but the colon was normal; in 6 cases one polyp was found in the colon, and in 1 case three polyps of the colon were found. Numerous polyps were present in 1 case and in 3 cases the polyps were innumerable. In each of 4 cases in which proctoscopic examination failed to disclose any polyps, roentgenologic examination revealed a polyp in the colon. In the 2 instances of chronic ulcerative colitis with pseudopolyps, the lesions were demonstrated roentgenographically.—*R. S. Bromer.*

Golding, H., and Delario, A. J. Left subphrenic abscess. *Radiology*, Jan., 1941, *36*, 61–71.

Left subphrenic abscess is more difficult to diagnose than right subphrenic abscess because it is much more infrequent and because gas which is normally present in the stomach and colon may mask the gas in an abscess. It may be a difficult problem to differentiate between gas in the stomach and gas in a left subphrenic abscess. Observation of several points may help to make a differential diagnosis, in addition to a careful history which is of great importance. Cases of subdiaphragmatic abscess have a high or elevated dome of the diaphragm which is thickened, with fixation on respiration, and often there is some fluid in the pleural cavity above it. Although a large magenblase would elevate the dome of the diaphragm, it would not cause the dome to be fixed, nor would there be thickening of the dome or pathology in the chest. Fluid in the chest due to heart disease or other pathology in a patient with a normal magenblase would obscure the height of the diaphragm and the thickness of the pleura, and the dome would not move on respiration. In such cases care must be taken to avoid a mistaken diagnosis of subphrenic abscess. Careful observation will show that gas in a subphrenic abscess is void of structure and is slightly

darker than the gas bubble in the fundus of the stomach. As a final diagnostic measure it may be necessary to remove the stomach contents to see whether the fluid line in the suspected abscess is changed. It may also be necessary to give the patient barium in order to differentiate between a subphrenic abscess with air and fluid level and a magenblase.—*Wendell C. Hall.*

Feldman, Maurice. Slight enlargement of the head of the pancreas; associated pathologic changes in the duodenum. *Radiology*, Feb., 1941, *36*, 224–229.

Formerly roentgen diagnosis of disease of the pancreas was not possible until the head of the pancreas was so greatly enlarged that it caused signs of pressure in neighboring viscera. Now it has been found possible to make the diagnosis when there is only slight enlargement of the head of the pancreas. The characteristic finding is an inverted figure 3 filling defect in the ampullary part of the duodenum. There is also displacement of the surrounding mucosa with piling up of mucosal folds and changes in the contour of the ampullary part of the duodenum.

Seven cases of slight enlargement of the head of the pancreas are described and illustrated with roentgenograms. The patients were all males, twenty-nine to sixty-nine years of age. In 5 of the cases there were pathological changes in the duodenum, consisting in 2 cases of an ulcer of the bulb, in 1 a duodenal ulcer with filling of the ampulla of Vater, in 1 a duodenal diverticulum and in 1 a duodenal polyp.—*Audrey G. Morgan.*

Robinson, Walter W. Oral cholecystography. *Radiology*, Feb., 1941, *36*, 131–144.

In a study of 2,235 cases examined by the oral cholecystographic method at the Crisler Clinic the diagnostic results have been 97.3 per cent correct, comparing closely with the percentage of correct diagnoses made by the intravenous cholecystographic technique. Normal filling of the gallbladder depends upon a closed sphincter of Oddi, its ability to concentrate depends upon a normal gallbladder mucosa, and its ability to change in size and empty depends on the contractility of the intrinsic musculature of the gallbladder wall.

It is very important that the sphincter of Oddi remain contracted during the starvation period of cholecystography in order that a maximum volume of the dye enter the gallbladder. It has been shown that sustained closure of the sphincter of Oddi is best accomplished by maintained alkalinization of the stomach and duodenum. The observation has also been made that gastric subacidity, provided the gallbladder is not diseased, increases the cholecystographic response, and that the dye concentrates even better if achlorhydria is present. The author feels that, conversely, hyperchlorhydria without the administration of alkali will often result in poor dye concentration, due most probably to relaxation of the sphincter—hence the poor visualization of the gallbladder in the presence of a non-obstructive duodenal ulcer with hyperacidity.

An empty relaxed gallbladder permits maximum concentration of dye-laden bile. Hence it is important that a fat meal be given three hours preceding administration of the dye. No examination of the gallbladder is complete without testing its contractility. Very frequently pathologic conditions such as polypoid tumors or small solitary stones are only seen after the gallbladder has contracted. Retarded contraction of the gallbladder may also signify the presence of a small non-opaque stone in the cystic duct with a ball valve action, or a chronic inflammatory process in the muscular coats of the organ.

The author's technique of oral cholecystography is as follows: Preliminary roentgenograms of the gallbladder area are made before giving dye. The patient takes a light evening meal containing some fats. Three hours later when the gastric acidity is at a minimum and the effect of the fat meal on gallbladder contraction has subsided the patient takes 4 grams of fresh sodium tetraiodophenolphthalein dissolved in 1 ounce of water to which 4 ounces of a fruit juice is added. Thirty minutes prior to administration of the dye the patient is given 1 dram of paregoric. One hour after ingestion of the dye 1 dram of sodium bicarbonate is given. No cathartic is given for a period twenty-four hours preceding the administration of the dye. Water may be taken in any amount during the examination. During the period between administration of the dye and the fat meal the average case receives 4 drams of soda but more may be given in cases of hyperchlorhydria. Twelve hours after taking the dye the first films are made and four hours later another series of films are made, at which time the dye concentration should be maximum. After this a fat meal is

given and the final films are made at two fifteen minute intervals and at the end of one hour. Glyconin fortified with lecithin is used for the fat meal.

The study of the gallbladder is usually combined with the barium study of the gastrointestinal tract. Films of the stomach and duodenum are made immediately after the twelve hour cholecystograms, and 1 dram of sodium bicarbonate is always added to the barium meal. The gallbladder examination is usually completed before the barium reaches the hepatic flexure. If barium or gas in the colon should obscure the gallbladder region before the cholecystographic studies are complete, 1 cc. of pitressin intramuscularly will usually aid in emptying the colon of its contents. In those cases where the gallbladder is not well visualized due to poor dye concentration a second dose of dye is given the second night. If the cholecystographic studies are completed the first day, a cathartic is given in preparation for the barium enema next day.

Intravenous cholecystography is seldom indicated except in cases of persistent vomiting and in obstructive lesions of the pylorus.—*Wendell C. Hall.*

Sjörgren, Sven Erik. Divertikelähnliche Bildung am Choledochus, nachgewiesen durch Cholangiographie. (Diverticulum-like structure of the common duct demonstrated by cholangiography.) *Acta radiol.*, 1941, *22*, 318–326.

Recently there has been an increasing use of cholangiography during operation. The author describes a case in a woman of forty-nine operated on for persistent pain after a cholecystectomy. Cholangiography during the operation showed a cyst on the posterior wall of the common duct about 4 cm. long and 3 cm. broad. Previous roentgen examination had shown a diverticulum of the duodenum in the region of Vater's papilla.

Diverticula of the common duct from epithelial nodules occur quite frequently in fetal life, but such diverticula are extremely rare in post-fetal life. The author knows of only 2 other published cases, that of Budde (1924) and that of Söderlund (1926). In the latter case there was a stone impacted in Vater's papilla, a dilatation of the common duct and a diverticulum the size of a goose egg on the lateral wall of the common duct. These cases seem to fill a gap between the fetal diverticula of the common duct and congenital idiopathic dilatation of the common duct.—*Audrey G. Morgan.*

Seids, J. V., and Hauser, Harry. Aneurysm of the splenic artery. *Radiology*, Feb., 1941, *36*, 171–180.

Aneurysm of the splenic artery is very rare and hard to diagnose during life. Less than 100 cases have been reported since the first case observed in 1847. Ten cases have been diagnosed during life and 2 before operation.

The author describes 2 cases, the first in a woman, aged fifty-nine, who complained of pain starting in the neck and radiating downward to both shoulders. She had lost 30 pounds in the past six months and suffered from weakness and indigestion. Examination showed marked arteriosclerosis and a firm mass in the left hypochondrium. Roentgen examination of the digestive tract showed nothing abnormal. There was a dense shadow in the upper left quadrant of the abdomen. Urologic studies showed that it was not connected with the urinary tract. An intern found that palpation of the abdominal mass showed pulsation and a bruit was audible on auscultation. This suggested aneurysm of the splenic artery, which was confirmed by operation. Adhesions to the pancreas and posterior wall of the abdomen made resection and splenectomy unadvisable. The splenic artery was ligated proximal to the aneurysm and the abdomen closed. Roentgen examinations one and two years later showed progressive regression of the calcified aneurysm.

The second patient was a man, aged sixty-five, who had no symptoms due to the aneurysm which was discovered on a routine roentgen examination of the spine. The roentgenogram showed a calcified mass posterior to the stomach and splenic flexure of the colon. A diagnosis of calcified aneurysm of the splenic artery was made. Recently an adenocarcinoma of the sigmoid portion of the colon developed for which combined abdominal and perineal resection was performed.

The symptoms of aneurysm of the splenic artery vary from the mildest types of dyspepsia to violent paroxysms of epigastric pain. Occasionally an enlargement of the spleen or an epigastric tumor may be found in a routine physical examination of a patient who has had no symptoms referable to this region. Perhaps the most practical suggestion in regard to di-

agnosis is to keep the possibility of such an aneurysm in mind whenever a tumor is found in the epigastrium or left hypochondrium, particularly if the spleen is enlarged. Palpation should be made for expansile pulsation and auscultation for a bruit. Surgical exploration in cases of abdominal hemorrhage should include examination of the splenic artery.

Treatment must be surgical. Ligation proximal or both proximal and distal to the aneurysm is the most conservative and usually the most effective method. Removal of the aneurysm and spleen has been performed successfully in some cases.—*Audrey G. Morgan.*

GYNECOLOGY AND OBSTETRICS

Rowden, L. A. Maternal mortality and radiology. *Brit. J. Radiol.*, June, 1940, *13*, 185–192.

In this twentieth Mackenzie Davidson Memorial Lecture the author emphasizes the importance of roentgen examination in the safe conduct of labor. By means of roentgen examination it is possible to diagnose pregnancy, determine the position and presentation of the child, demonstrate multiple pregnancies and deformities of the fetus and determine the size of the child, particularly the head.

Determination of the pelvic measurements is most important, particularly in primigravidae. He recommends roentgen examination of all primigravidas as a matter of routine and the provision of roentgenographic facilities for all antenatal clinics. Some large city should be selected, such as his own city of Leeds for example, and routine examination made of all primigravidas and the effect on the fetal and maternal death rate noted. As Leeds has about 2,000 primiparas yearly this would not involve very serious expense and the plan would more than pay for itself in the saving of expense in difficult cases where the difficulties could be foreseen and rectified. Maternal mortality has been lowered in Leeds since 1931 from 5.4 per thousand births to 1.12. He thinks this is the lowest rate for any large city in the country and thinks it is due largely to the increasing use of prenatal roentgen examination.—*Audrey G. Morgan.*

SKELETAL SYSTEM

Bosworth, Boardman M. Examination of the shoulder for calcium deposits. *J. Bone & Joint Surg.*, July, 1941, *23*, 567–577.

Not infrequently, Bosworth states, calcium deposits in the region of the shoulder joint are discovered accidentally in roentgenograms of the chest or the upper extremity. Usually the patient is unaware of the presence of the calcium; the physician regards it as merely an incidental finding of no clinical significance, and nothing is done about it. Lately, however, more interest has been shown in these deposits, and their importance as a potential source of pain and disability is now generally recognized.

Although various roentgenographic techniques in the examination of the shoulder for calcium deposits have been recommended, no one has stressed the importance of fluoroscopy as a preliminary procedure for the detection of calcium or advocated the combination of spot film roentgenography with fluoroscopy as the best means of recording the precise location of such deposits. In a three year survey of over 6,000 supposedly normal individuals whose shoulders were examined for calcium deposits, most of them at intervals of a year or less, fluoroscopy was found to be the preferable method. Deposits may be overlooked in the roentgenogram when they are superimposed upon the head of the humerus or the overlying acromion. The density of the shadow cast by deposits in the roentgenogram varies greatly. The calcium is usually spread out in a thin layer which casts little or no shadow unless it is so placed between the tube and film that the roentgen rays have to traverse the length or breadth rather than the thickness of the deposit. If examination is restricted to roentgenography, many roentgenograms should be taken of each shoulder in different planes and with varying degrees of humeral rotation. Even then, Bosworth claims, calcium collections which would be seen on fluoroscopy may be missed entirely. The expense of such examination and its inherent element of error are self-evident. Fluoroscopy, properly performed, makes visible very nearly the full extent of the shoulder joint capsule within the space of a few moments. It is effective, speedy and relatively inexpensive.

Time after time, the author states, a deposit clearly seen by fluoroscope failed to appear on films taken later, simply through failure to have the arm in exactly the right position during roentgenography. This led to the development and adoption of the spot film technique.

The paper is illustrated with roentgenograms showing various planes of the shoulder joint and the various positions of the deposit de-

pending upon the direction of the vertical ray and other technical factors. The precise location which can be obtained by the method of the author is most important when operative removal of the deposit is contemplated. The spot film method involves the loss of a very small amount of photographic definition, but when fine bone detail is desired, further roentgenograms may be taken according to standard techniques. The danger of fluoroscopy is emphasized and careful training in roentgenographic procedures is advocated before undertaking the author's technique.—*R. S. Bromer.*

Axén, Oliver. Über den Wert der Arthrographie des Schultergelenkes. (The value of arthrography of the shoulder joint.) *Acta radiol.*, 1941, *22*, 268–276.

The author describes the technique of injecting perabrodil into the shoulder joint for making roentgenograms. This method has been used since the end of 1938 at the Seraphim Hospital in Stockholm in 173 cases, 118 in men and 55 in women. The method is useful in demonstrating ruptures in the joint capsule and in the tendon of the long head of the biceps muscle. Illustrative roentgenograms are given.

Among these cases pathological changes were found in 69 and in 13 of these operation was performed. Only 7 of the patients with pathological changes were less than fifty years old. The percentage of ruptures increases with increasing age. In this material there were a few more women than men, though in almost all previous collections of statistics ruptures of the tendon of the supraspinatus have almost all been in men.

In 28 cases examination was also made of the uninjured shoulder in order to determine whether rupture might exist without trauma and without causing clinical symptoms. Such ruptures were found in uninjured shoulders, indicating that there were pathological changes which brought about a communication between the joint and subacromial bursa before any injury occurred.—*Audrey G. Morgan.*

Rendich, R. A., and Poppel, M. H. Roentgen diagnosis of posterior dislocation of the shoulder. *Radiology*, Jan., 1941, *36*, 42–45.

Posterior dislocation of the head of the humerus is uncommon, its clinical diagnosis is difficult, and roentgenologically the diagnosis is practically always missed on single anteroposterior or posteroanterior views. Posterior dislocation of the humeral head can be classified as subacromial and subspinous, the latter being most uncommon. Accurate roentgen diagnosis can be established by stereoscopic films, and by single films, the following points or technique to be applied when single films are used:

1. With a posterior dislocation the humeral head is directed posteriorly and medially. A markedly rotated normal head of the humerus simulates this somewhat although the head, in the case of rotation, is directed laterally instead. In either case the lesser tuberosity and greater tuberosity may be profiled medially.

2. With posterior dislocation the lower third of the glenoid fossa is exposed due to the displaced head. This, together with the direction of the head and position of the tuberosities is diagnostic.

3. The vertical view, either supero-inferior or infero-superior, is valuable for confirmatory purposes.—*Wendell C. Hall.*

Trynin, Aaron H. Intercondylar T fracture of elbow. *J. Bone & Joint Surg.*, July, 1941, *23*, 709–711.

For the treatment of intercondylar or T-fracture of the elbow, Miller has suggested nailing the fragments and Reich has advocated traction, both of which methods undoubtedly will produce excellent results in many cases. Manipulation and closed reduction are always the method of choice, provided reduction can be obtained by this means. Trynin reports a case of T-shaped fracture of the elbow treated by closed reduction. The case is interesting, because the roentgenograms were misinterpreted by a number of competent roentgenologists. A careful study of the films, however, showed the correct relationship of the fragments, and closed manipulation, together with lateral compression of the elbow by means of a carpenter's clamp, resulted in a good alignment and a useful elbow. —*R. S. Bromer.*

Blum, Lester. The treatment of Bennett's fracture-dislocation of the first metacarpal bone. *J. Bone & Joint Surg.*, July, 1941, *23*, 578–580.

According to Blum, the stave or boxer's or Bennett's fracture is an injury owing its origin to the disparity between an individual's pugnacity and his pugilistic technique. It occurs when the full force of a blow impinges on the

flexed thumb, instead of on the fist, with direct transmission along the first metacarpal shaft. The resultant fracture consists of an oblique break through the base with lateral luxation at the metacarpal joint, and the proximal fragment, or medial angle at the base, remaining in anatomical position. This is the characteristic pattern, though various degrees of comminution may occur. It is this resemblance to the forked staff of the medieval monk which accounts for the descriptive term "stave."

Blum advocates treatment of this lesion as follows: A physiotherapy treatment (radiant heat) is administered each day for the first two weeks. A narrow ace bandage is applied between treatments to the wrist and the base of the thumb. The patient is allowed to use the thumb to the limits of pain. During the third week, the patient is allowed to return to his occupation, unless it is exceedingly heavy work, and no further treatments are administered unless the swelling persists. Full motion of the thumb is usually obtained. By the fourth week, all crepitus and evident false-point motion on direct pressure over the site of the injury disappear. At the end of the seventh week, roentgenograms usually show the defect between the fragments to be filled in with a typical stave deformity of the base of the metacarpal.

If the malposition of the fragments in a Bennett's fracture is allowed to heal without reduction, a new joint mortice is formed. Thus the normal diarthrosis becomes an enarthrosis, or ball-and-socket joint. In view of the difficulty in maintaining a successful reduction in this fracture-dislocation, and because of the real possibility that the changes mentioned may represent a structural improvement over the normal, Blum suggests that simple physiotherapy and bandaging to relieve the soft tissue swelling constitute a shorter, simpler and perhaps a better method of treatment than those usually advocated. The two most accepted methods are: (1) traction in adduction by moleskin, or a wire through the shaft with the apparatus mounted in plaster on the wrist and forearm, (2) plaster encasement after reduction with the thumb in full abduction, pressure over the basal portion of the bone being applied when reduction is attempted.—*R. S. Bromer.*

KING, DON, and RICHARDS, VICTOR. Fracture-dislocations of the hip joint. *J. Bone & Joint Surg.*, July, 1941, *23*, 533–551.

Before the advent of the automobile and the roentgen ray, dislocations of the hip associated with fractures of the acetabular lip held a fascination for the surgeon largely because of their rarity. Diagnosis could only be established with certainty by postmortem examination, and consequently the lesion was rarely recognized. In 1927, Breton and Blondeau pointed to the increasing frequency of the lesion in automobile accidents and gave it the name "automobile injury" of the hip joint. The authors review the literature and show that posterior dislocation of the hip while recognized more often is still comparatively uncommon. It is, however, increasing in frequency. Without perfect reduction, arthritic disintegration of the joint occurs rapidly, due to mechanical incongruity of joint surfaces. Roentgenograms of good quality must be studied with care before the reduction is accepted as satisfactory. They state that open reduction is indicated when:

1. The lip fragment is large and does not come down into position when the head is reduced (unstable reduction).
2. The lip fragment is in the acetabulum.
3. Sprain fracture of the head of the femur prevents perfect reduction.
4. A fracture through the acetabular floor allows rotation of the distal fragment which prevents reduction.
5. Femoral shaft fracture prevents control of the head. Satisfactory results have been obtained by the authors by open reduction.—*R. S. Bromer.*

HIGHT, DONALD. Spontaneous fracture of the femoral neck following roentgen-ray therapy over the pelvis. *J. Bone & Joint Surg.*, July, 1941, *23*, 676–681.

Hight reports a case of spontaneous fracture of the femoral neck following roentgen therapy over the pelvis. The patient was a male, aged fifty-eight, who had an extensive infection in a new growth involving the penis with a firm palpable node in the right inguinal region. A radical amputation of the penis was done. He received a total of 1,600 roentgens through each of two portals, 10 by 15 cm., a portal being located over each groin. The fracture which developed is the first occurring in the author's hospital in a series of 1,084 cases receiving roentgen treatment over the pelvis, an incidence of 0.09 per cent.

Inasmuch as the case Hight presents received less dosage than cases previously reported which showed no apparent change in

the femoral neck, he feels that it is not justifiable to assume that the pathological changes were entirely due to changes secondary to the roentgen treatment. It seems likely that the extent of vascular damage caused by arteriosclerosis would be an important contributing factor. The fracture thus resulted apparently from weight bearing in the presence of marked osteoporosis developing in a bone whose blood supply had first been impaired by arteriosclerosis, and was then further damaged by the roentgen therapy and fibrosis.

At the present time, about three years since the fracture occurred, there has been no callus formation demonstrable by roentgenograms. Hight concludes that when roentgen therapy is given over the pelvis, the portals should be placed so that they do not include the region of the femoral necks. If this is unavoidable, the portals should be as small as possible.—*R. S. Bromer.*

Inman, Verne T., and Smart, Bret W. Irreducible lateral dislocation of the patella with rotation. *J. Bone & Joint Surg.*, July, 1941, *23*, 695–700.

While most dislocations of the patella are readily reduced, there have been reported from time to time cases of luxated patellae which have defied all attempts at closed reduction. Usually these dislocations have been complicated by fractures, luxations of the tibia, or rotary displacements of the patella. The authors report a case which is of interest in that the lateral dislocation was associated with a complete rotation of the patella about its longitudinal axis. Their search through the literature uncovered few similar cases of lateral dislocation with such complication. From their review of the reported cases and from the study of their own case, it is apparent, they believe, that the lesion must result from a blow directly upon the medial side of the patella while the quadriceps femoris is taut. It appears to be essential that the knee must be in almost complete extension at the time the forces act. This fact suggests the explanation for the rotation of the patella. During the final 20 to 25 degrees of extension of the knee, the patella rides against the lateral femoral condyle, which is bulwarked to resist the normal tendency of the patella to slide laterally. When the dislocating force carries the patella laterally, its outer edge must ride upon the raised lateral femoral condyle. This produces a torque, tending to rotate the patella about a longitudinal axis. If the primary force is sufficiently great and acts through an adequate period of time, the patella is not only rotated, but is carried beyond the lateral femoral condyle over which the medial edge of the patella becomes locked.

Although manual reduction is perhaps possible, once the nature of the rotation has been detected, the authors feel that open reduction is probably the method of choice in order to repair these important attachments, and to restore the full strength of the limb, and prevent any further tendency to lateral dislocation. —*R. S. Bromer.*

Wilson, Philip D. A simple method of two-stage transplantation of the fibula for use in cases of complicated and congenital pseudarthrosis of the tibia. *J. Bone & Joint Surg.*, July, 1941, *23*, 639–675.

Wilson describes a simple method of two-stage transplantation of the fibula into the tibia, and reports the results obtained by its use in a group of 9 cases of complicated pseudarthrosis of the tibia. These included 4 adults of whom 3 had infected pseudarthrosis, and 1 uninfected, but with pseudarthrosis still present following two previous bone-grafting operations; and 5 children with congenital pseudarthrosis or pseudarthrosis resulting from operative correction of congenital bowing, in 4 of whom previous bone-grafting operations had been done with failure. Bony union of the pseudarthrosis developed spontaneously in 6 of these 9 cases, and in the other supplementary bone-grafting operations resulted in success.

Wilson believes that fibular transplantation has a much wider application in the treatment of tibial pseudarthrosis than has been previously realized, and should not be reserved for those cases in which there are gross tibial defects. The method is worth consideration in cases of infected or complicated pseudarthrosis, and also in the congenital pseudarthrosis of childhood.—*R. S. Bromer.*

Hansson, C. J. Arthrographic studies on the ankle joint. *Acta radiol.*, 1941, *22*, 281–287.

The author describes the technique of injection of perabrodil into the ankle joint for purposes of arthrographic study. During the exposure the foot was pressed up against the leg. Besides frontal and lateral views, other views were taken with the foot in positions of extreme adduction and abduction. The patients suffered no discomfort from the examination except

slight burning pain for about an hour in cases in which there had been leakage from the capsule or joint.

Examinations were made in 48 cases, in 26 of which the findings were normal. By this method a reliable diagnosis can be made of ruptures of the ligaments or capsule; this is not always possible on ordinary roentgenograms of the joint unless there is definite subluxation. It is also of value in the demonstration of rupture of the tibiofibular joint.—*Audrey G. Morgan.*

BASS, MURRAY H. Solitary eosinophilic granuloma of bone. *Am. J. Dis. Child.*, June, 1941, *61*, 1254–1262.

Bass calls attention in this communication to an unusual form of bone granuloma and reports 2 cases which occurred in his practice. Solitary eosinophilic granuloma of bone is apparently a distinct disease entity. In addition to the 2 cases which he reports, 8 others were found on record in the literature. The cases are reported in detail. In each of his 2 cases a single bone lesion was found. In the first patient it was painless, and in the other the region involved was tender and painful. Both patients were operated upon and the type of tissue found in the lesion was similar in the 2 cases. After wide excision, roentgen treatment was given and both patients made perfect recoveries. The patient in the one instance has been in excellent health for almost six years since operation, and the second patient has been well for almost a year.

In the first patient a roentgenogram of the skull showed a circular defect near the frontoparietal suture, left side measuring about 2 by 3 cm. on the film. In the second patient, the lesion was situated in the fifth rib, right side, and resembled an expansile tumor, somewhat oval in shape and sharply demarcated. The microscopic examination of the specimen removed at operation in the second patient showed the medullary cavity to be composed of a substratum of fairly large cells with pale nuclei. Some of these cells had two or three nuclei and were large and distinctly of the giant cell type. This supporting tissue was heavily infiltrated with polymorphonuclear leukocytes, but nowhere could abscess formation or other indications of an acute suppurative process be seen. The majority of the polymorphonuclear leukocytes permeating the tissue were eosinophilic. The pathologist felt that all the usual types of malignant bone lesions including Ewing's tumor and spindle cell or osteogenic sarcoma could be ruled out. Certain features strongly suggested that it was some sort of granuloma.

Bass concludes that roentgenologically the disease process fulfills all the criteria of malignant disease of bone. He regards it important to know of this condition since, though clinically and roentgenologically it closely resembles malignant disease, it is benign and by operation and irradiation the patient may be permanently cured.—*R. S. Bromer.*

EINHORN, NATHAN H., MOORE, JOHN ROYAL, OSTRUM, HERMAN W., and ROWNTREE, LEONARD G. Osteochondrodystrophia deformans (Morquio's disease); report of three cases. *Am. J. Dis. Child.*, April, 1941, *61*, 776–794.

The records, together with the results of study of 3 cases of osteochondrodystrophia deformans, are presented by the authors, and problems relating to diagnosis and to the pathogenesis of some of the clinical manifestations of the disease are discussed. They collected 40-odd cases described in the literature as Morquio's disease of which only 35 according to their opinion conformed to Morquio's original description. The remaining cases, as well as a number described before 1929 which are often cited, may not be true instances of osteochondrodystrophia deformans. At least, they think, they must be regarded as atypical. The atypical features may be grouped under the following headings: (1) obesity, nanism; (2) local malacias of the shoulder and hip joints, resembling Perthes' disease; (3) mental retardation and general enlargement of the joints; (4) gargoylism, congenital clouding of the cornea, hepatosplenomegaly and mental retardation; (5) alteration in the size and shape of the head, shortness of all four limbs and a normal trunk.

Little difficulty is encountered in diagnosis once the disease is well established, while more or less uncertainty attends its recognition in the early stages. They regard it as apparent that there is no group of classic, early manifestations which characterizes the condition in all cases. The greatest help in establishing the diagnosis is derived from roentgenologic studies. From an orthopedic point of view, Morquio's disease presents a group of interesting deformities, namely: pes planus, genu valgum, coxa vara, scoliosis, kyphosis, pectus cari-

natum, mild clubhand, humerus varus and skeletal dwarfism. They are due to structural defects, to postural changes and to a combination of the two.

In one of the cases reported, definite platybasia was discovered which may be of the utmost significance since it would bring the neurologic changes encountered in patients with this disease in line with those seen in persons with multiple sclerosis or amyotrophic lateral sclerosis which according to Chamberlain are related to platybasia.

The 3 cases are reported in detail with roentgenograms illustrating the bony dystrophic changes and with tables giving the roentgenographic data, points of differentiation of osteochondrodystrophia deformans, chondrodystrophia and rickets; and a third with laboratory data of the 3 patients.—*R. S. Bromer.*

Boyd, Julian D., and Stearns, Genevieve. Late rickets resembling the Fanconi syndrome. *Am. J. Dis. Child.*, May, 1941, *61*, 1012–1022.

Three cases are reported in this paper which have certain factors in common. These included evidence of onset of the disease during infancy, retardation of growth to a marked degree, hypophosphatemia which did not respond to the usual antirachitic measures, marked osteoporosis and rickets-like lesions in the epiphyseal zones, and undernutrition. From the metabolic standpoint, the 3 patients had rather dissimilar disturbances. The one case presented the most outstanding evidences of demineralization and was the youngest of the group. His associated metabolic dysfunction was characterized by glycosuria. Albuminuria and polyuria were not noted but the possibility that they were present and escaped detection could not be eliminated. The child presented no ketosis, and his alkali reserve and blood sugar levels were normal. The second case which presented glycosuria did not have a larger urinary output than would be expected from the degree of glycosuria present. She had marked ketosis which led to acidotic levels of the blood constituents. There was nothing to suggest that the acidosis was dependent on renal dysfunction. There was also no evidence to indicate that the glycosuria was due to diabetes mellitus as it was fairly constant in degree, and did not fluctuate appreciably with the dietary intake or administration of insulin and was not associated with hyperglycemia.

The third patient was not glycosuric but his urine did contain moderate amounts of albumin. He had polyuria and polydipsia with urine of low specific gravity. The other findings were not associated with the usual form of renal dysfunction. There was no retention of nitrogenous metabolites. The kidneys at postmortem showed no histologic evidence of a chronic lesion, yet the possibility that minor chronic pathologic alterations were masked by the acute degenerative changes due to diphtheritic toxicosis could not be ignored. The alkali reserve was normal.

The authors ask whether it is possible to consider the illnesses of these three children as examples of a common entity. To do so, they state, implies commonness of causation. Fanconi attributed the rachitic changes in his group of patients to renal dysfunction of a type different from that of patients with renal insufficiency, as exemplified by the renal dwarf. They regard it as reasonable to suppose that disturbances of tubular function may give rise to alterations in renal elimination of such nature that the mineral balance of the body is upset and demineralization occurs. Albuminuria, renal glycosuria or polyuria could be accepted as evidences that tubular dysfunction was the basis of the difficulty. Agencies remote from the kidney may cause similar derangements of metabolism, however. It seems probable that in certain instances late rickets is due to perversion of tubular renal function just as in other instances it is associated with renal inadequacy of the usual type. However, the authors regard it as equally apparent that extrarenal agencies which interfere with the normal metabolism of water or of electrolytes may cause demineralization of bone and interference with the normal formation of bone and may be associated with secondary evidences of renal dysfunction. They state the etiologic classification of late rickets is not simple, nor can it be made on the basis of causal clinical or laboratory observations. Only through familiarity with the causative mechanism in each individual patient can therapeutic measures be directed into channels of maximum efficiency.—*R. S. Bromer.*

Scott, Roland B. Congenital absence of the fibula; its occurrence in a premature Negro infant. *Am. J. Dis. Child.*, May, 1941, *61*, 1037–1043.

Scott reports a case of congenital absence of

the fibula in a premature infant. In addition to absence of the fibula, he states, the syndrome characteristically consists of: (1) shortening, anterior bowing and dwarfing of the affected leg; (2) shortening and anterior bowing of the tibia; (3) equinovalgus position of the foot, with relaxation of the ankle joint; (4) absence of the external malleolus; (5) absence, delay in appearance or fusion of some tarsal or metatarsal centers of ossification, and (6) absence, webbing or hypoplasia of the toes. He thinks the deformity apparently results from an intrinsic defect in the germ plasm. The prognosis for satisfactory function is not good. The diagnosis should be made in the newborn period and an orthopedist should be consulted about the management of the patient before atrophy of disuse appears.—*R. S. Bromer.*

RENDICH, RICHARD A., and HARRINGTON, LEO A. Roentgen findings in caisson disease of bone, with case reports. *Radiology*, Oct., 1940, *35*, 439–448.

The primary lesion in caisson disease is an accumulation of nitrogen gas in the bone with a resultant massive aseptic necrosis. Four cases are described and illustrated with roentgenograms. They include cases with typical medullary necrosis and calcification and ones in which the characteristic calcification is absent. There is often chronic hypertrophic osteoarthritis.—*Audrey G. Morgan.*

WILKIE, JOHN. Two cases of fluorine osteosclerosis. *Brit. J. Radiol.*, June, 1940, *13*, 213–217.

The changes caused in bone by exposure to fluorine compounds were first described by Flemming Møller and Gudjonsson in 1932. These changes were found in the examination of cryolite workers. Cryolite is a double fluoride of sodium and aluminum used as a source of metallic aluminum. Mottled teeth have been reported in children and young adults caused by drinking water which contains considerable amounts of fluorine compounds.

In this article 2 cases of fluorine osteosclerosis are described and illustrated by roentgenograms. The first was in a man of forty-seven who had been engaged in the preparation of aluminum fluoride for three and a half years. The spine showed generalized sclerosis of the vertebrae and the long bones of the limbs, and the bones of the hands and feet showed loss of detail in the spongiosa and poor demarcation between cortex and medulla.

The second case was in a man of sixty-four who had worked for sixteen years in the same factory as the first patient and had been engaged in the making of hydrofluoric acid. The bone changes were similar to those in the first case but much more advanced. The spine and pelvis showed very dense sclerosis and the legs showed extensive ossification of the ligaments.

Differential diagnosis, which is not particularly difficult, is discussed. In these cases the diagnosis was confirmed by the fact that similar changes were found in other workers in the same factory and there was an increase in the fluorine content of the blood and urine. Some men who have worked for years with fluorine compounds do not show these changes, which suggests that some other factor may be necessary to cause the deposition of fluorine in the bones, possibly some metabolic factor.—*Audrey G. Morgan.*

FAWCITT, RICHARD. Osteochondritis vertebralis (Calvé) associated with pathological changes in other bones. *Brit. J. Radiol.*, May, 1940, *13*, 172–178.

A case is described in a girl of four first sent to the hospital on January 19, 1938. She had for some time been complaining of pain in the lumbar spine accompanied by loss of weight and appetite. On admission the lumbar spine showed reversal of the normal lordosis and all movements were restricted by muscle spasm. A roentgenogram showed collapse of the third lumbar vertebra; the appearance suggested Calvé's vertebral osteochondritis. Roentgenograms were taken monthly for two years and many of them are reproduced.

As time progressed the fourth lumbar vertebra also collapsed. Healing took place in the third lumbar vertebra and cystic changes developed in the proximal parts of the femurs and humeri. Stones developed in both kidneys and the child was sent to the Manchester Royal Infirmary for treatment of the kidney condition.

This is apparently a case of Calvé's vertebral osteochondritis which was first described in 1924. No changes in other bones have been noted in the cases reported but, on the other hand, it is not known whether a systematic examination for them was made. Examination for tuberculosis was negative in this case and

there was nothing in the roentgenogram to suggest syphilis. The cystic changes in the bones with a tendency to recovery and the high blood calcium suggest an endocrine disturbance. There was no bending of the bones nor were the cysts distributed throughout the shaft as in generalized osteitis fibrosa.—*Audrey G. Morgan.*

Vosburgh, Richard K., and Alderman, Jerome E. Testicular teratoma metastasizing to the spine. *J. Bone & Joint Surg.*, July, 1941, *23*, 701–708.

The authors state that it is generally believed that more than 96 per cent of testicular tumors are malignant. Metastasis occurs by way of the lymphatic and venous systems. When by the lymphatic route, extension is up the lymphatics of the spermatic cord to the pelvic, lumbar, and epigastric nodes, thence to the prevertebral chain, through the mediastinum and along the thoracic duct to the left supraclavicular fossa. When by the venous system, metastasis is first pulmonary in nature. By either route the metastasis is rapid. A laboratory aid in diagnosis and prognosis is to be found in the determination of the presence of prolan A in the urine. This test has now been refined and is used not alone in diagnosis, but as a guide to the progress of the patient, and the response of the tumor to irradiation. The persistence of a strongly positive prolan test after orchidectomy is considered evidence of subclinical metastasis when other examination for this is negative.

There are surprisingly few reports in the literature pertaining to teratoma of the testicle metastasizing to bone. Vosburgh and Alderman report a case which metastasized to the spine causing paraplegia and sensory loss below the level of the involvement of the spinal cord which presented the following unusual features:

1. The length of time in which the mass in the testicle had been known to exist (six years).
2. Trauma sufficient to cause a compression fracture of the spine preceded the onset of symptoms.
3. Absence of evidence of invasion of the central or peripheral nervous systems up to the time the compression fracture was reduced.
4. Absence of evidence of involvement of bone or the spinal cord at the time the first laminectomy was performed.
5. Lack of roentgenographic evidence of the true pathological nature of the involved vertebrae at the first examination.—*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

Isola, Armando. Nuovi progressi nella arteriografia. La seriografia e la fotoradiografia. (Recent progress in arteriography. Seriography and photoroentgenography.) *Radiol. med.*, Jan., 1941, *28*, 28–43.

In a good arteriogram it is necessary not only to show the main trunk and the chief branches of the artery, but also the finest and most distal ramifications. This cannot be done with the usual film 30×40 cm. in size, for with this film only a limited segment of the artery can be shown. The author has devised a seriography by means of which it is possible to get a more prolonged view of the course of the opaque fluid through the artery. He takes four photographs 15×40 cm. in size at varying intervals of time. By varying the intervals suitably he has even been able to obtain images of both veins and arteries with a single injection of opaque fluid. Two diagrams of the apparatus and arteriograms of 3 cases are shown. But even this apparatus does not make the whole of the artery visible for the length of the seriogram is only 40 cm., while the limb is much longer than that.

He has also tried to apply roentgenoscopy to arteriography. In this way, two fluorescent screens are used placed end-to-end, on which the limb is laid and a series of roentgenoscopic exposures made. In this way it is possible to get a complete picture of the course of the contrast substance through the artery. But in spite of some technical devices, of which the author made use, the results were not entirely satisfactory because the images were not very clear. There was a great deal of granulation and consequently a lack of detail. He thinks this method cannot be used in arteriography until it is perfected further.—*Audrey G. Morgan.*

Lindblom, Knut. Phlebographische Untersuchung des Unterschenkels bei Kontrastinjektion in eine subkutane Vene. (Phlebographic examination of the leg by means of contrast injection into a subcutaneous vein.) *Acta radiol.*, 1941, *22*, 288–296.

The author reports injection of abrodil directly into a vein of the foot in order to make phlebographic examination of the veins of the leg. He gave the injections both to normal sub-

jects and those with varices and deep thromboses. As a rule, 20 cc. 35 per cent abrodil was injected in about a minute into a vein on the dorsomedian side of the great toe, and roentgenograms taken after one-half, two and sometimes four minutes.

Good pictures of the veins of the leg were given when the phlebograms were made with the subject standing or sitting or lying with the leg hanging down. This was true of both normal and pathological cases. But with the patient lying down and the leg stretched out horizontally the contrast medium tended to sediment and gave pictures that resembled thromboses or a blocking of the veins. That was apparently the reason for some misinterpretations in Bauer's pictures. The author has obtained phlebograms in normal individuals similar to those described by Bauer as thromboses. The results are better if the patient draws his knee up so that the leg forms an angle to the bed or table. The deep veins may not fill if the vein into which the injection is made is not exposed and found to connect with the deep veins. If the circulation is rapid there may be a central defect due to the contrast medium being carried away by the blood.—*Audrey G. Morgan.*

GENERAL

Berven, Elis, and Lysholm, Erik. Gösta Forssell. *Acta radiol.*, Nos. 1–2, 1941, *22*, 1–10.

These two numbers are published as a memorial in honor of the sixty-fifth birthday of Prof. Gösta Forssell who has rendered such signal service to Swedish radiology. He established the roentgen services of the Seraphim and Carolin Hospitals and the Radiumhemmet and these numbers are devoted to the results obtained in these institutions in recent years. Prof. Forssell is still very active, particularly in his work on the mucous membrane of the digestive tract. A complete bibliography of his works is given.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Peake, John Day. The systemic care of the patient undergoing radiation therapy. *Radiology*, Feb., 1941, *36*, 181–188.

The author stresses the fact that the roentgenologist must not only apply radiation in the most effective manner but must know how to treat his patient's general condition and must understand him as a human individual. He discusses four classes of problems that must be dealt with: (1) the patient's mental state; (2) radiation sickness; (3) care of specific organs, and (4) pain.

As these are cancer patients the question of what to tell the patient must be considered. Some member of the patient's family must be told the truth and he must be told as much of it as he is thought able to bear.

In radiation sickness the patient should be encouraged to take some exercise. Free elimination of bowel and kidneys should be provided for. The diet should contain plenty of fruits and liquids and easily digested carbohydrates. The patient must get plenty of rest, even if sedatives have to be given. Usually some vitamin B preparation should be given.

In the discussion Dr. Murphy said he had found liver extract very effective. Dr. Stone said that it has been claimed that high voltage radiation does not cause radiation sickness but that if it is given in equivalent biologic doses it causes just as much sickness as other voltages do.

Simple directions are given for the care of the skin and digestive tract and for the control of pain. The author says he has not attempted to present anything especially new but to assemble the known facts on these points and emphasize the necessity for systemic as well as specific roentgen treatment.—*Audrey G. Morgan.*

Tenopyr, J., and Silverman, I. The importance of biopsy in tumor diagnosis. *Radiology*, Jan., 1941, *36*, 57–60.

The aspiration biopsy at present is the least traumatizing and simplest type of biopsy to take. Some of the indications for needle biopsy are: (1) cases in which preoperative irradiation is indicated and where a biopsy is necessary to establish the diagnosis and the type of cancer; (2) to differentiate between cancer and traumatic fat necrosis; (3) enlargement of the liver where a differential diagnosis from cirrhosis is important for prognosis as well as therapy; (4) lung tumors; (5) bone tumors.

A new biopsy needle is described. The needle consists of two parts: an ordinary outer needle of 14 gauge and an inner needle of 17 gauge which is loosely fitted, split in half longitudinally, and protrudes ½ inch beyond the point of the outer needle. Many types of neoplasm in various organs have been biopsied with this needle and no difficulties were encountered in getting a satisfactory specimen. There have

been no failures to obtain tissue in any case. The technique of using the needle is simple. After raising a small intradermal wheal with 0.5 per cent procaine hydrochloride, the skin is pierced with the point of a scalpel. The outer needle is then passed up to the surface of the tumor through the skin incision, with the inner needle in place two-thirds of its length. With the point of the outer needle at the tumor surface the inner needle is then advanced into the mass. The bevel of the split inner needle is so made that the two prongs diverge as they advance into the tumor. The outer needle is then advanced into the tumor, causing the two halves of the split needle to be compressed, severing the attachment of the enclosed specimen from the surrounding tissue.—*Wendell C. Hall.*

Carling, E. Rock. Irradiation assailed, or the buried talent. *Brit. J. Radiol.*, March, 1940, *13*, 73–81.

This is the Skinner Lecture, the subject of which is cancer of the breast but the author gives a philosophical discussion of the use of irradiation and answers the criticism of Sir Leonard Hill who charges that radium has been exploited by those who make money out of it and says that the world would be little the worse off if all the radium now buried for security from bombing were left buried. He reviews the use of irradiation, both roentgen and radium, in various forms of disease and concludes that irradiation is now an indispensable part of medical treatment. The possible developments of irradiation are far from being exhausted and to bury the talent would be wrong.

As for cancer of the breast, he advises surgical removal of the primary tumor followed by postoperative irradiation. He is not inclined to favor preoperative irradiation because of the delay in operation that it involves but does advise its use in chronic interstitial mastitis and the serious pregnancy and puerperal cases. In these cases he gives as thorough an irradiation as possible in as short a time as possible and operates immediately. Only a few of these cases can be saved even by preoperative, operative and postoperative treatment combined.—*Audrey G. Morgan.*

Murphy, J. T., and Hufford, C. E. The use of 200,000 volts in the treatment of advanced superficial cancer. *Radiology*, Jan., 1941, *36*, 23–33.

The fact that 4,000 persons die from skin cancer in the United States each year leaves much to be desired in education of the public. The authors use unfiltered radiation, 120 kv., 8,000 to 10,000 r, divided into two or three doses in the treatment of early skin cancer. In their advanced cases they use 200,000 volts, higher filtration, and a total dose of more than 4,500 r in most cases. Adequate treatment of early cases of superficial cancer would avoid the necessity of using such high voltage treatment, but by using this high voltage some advanced cases can be cured which would otherwise be lost. The method of choosing their cases for higher voltage therapy is somewhat arbitrary, but is more or less determined by the size and thickness of the lesion and the type of tissue involved. They give 7 case reports on patients treated with 200,000 volts: (1) a carcinoma of the lip which had been insufficiently treated eight years previously and had progressed beyond the stage of probable satisfactory treatment by the usual unfiltered technique; (2) a large cauliflower squamous cell epithelioma on the helix of the ear, about 3 cm. in diameter and very thick; (3) a basal cell epithelioma on the nose which failed to heal or recurred under several treatments with superficial voltage; (4) a large ulcerated cauliflower lesion on the lower lip, about 2 cm. thick and 2.5 by 5 cm. across; (5) an anaplastic epidermoid and prickle cell carcinoma on the right side of the neck below the angle of the jaw, about 2.5 by 4 cm. in size, previously treated elsewhere by lightly filtered roentgen rays; (6) a squamous cell epithelioma, extensive and fulminating, involving almost the entire lower lip; (7) extensive ulcerating epithelioma of the right upper lip.

Fractionation of dosage with heavy filtration permits a lethal tumor dose to be given without unduly sacrificing recovery ability of normal tissue. A severe epidermitis is obtained by their treatment without permanent injury to the underlying corium. The height of the reaction is usually reached from four to six weeks after treatment is started, or in ten days to two weeks after irradiation is stopped. Complete healing usually requires two to four months after treatment. Little significance can be placed on the type of cellular growth in effective treatment of skin cancer since many

lesions show both basal and squamous cell proliferation and the amount of treatment must be sufficient to be lethal to all tumor cells.—*Wendell C. Hall.*

POPP, W. C., and ADDINGTON, E. A. Roentgen therapy for psoriasis of the nails and psoriatic arthritis. *Radiology*, Jan., 1941, *36*, 98–99.

The authors do not recommend roentgen therapy as a cure for psoriasis of the nails and psoriatic arthritis. Beneficial results from irradiation will, at best, only be temporary. However, they feel that the treatment which they outline is helpful in overcoming the marked disfigurement of the nails as well as in relieving the symptoms of psoriatic arthritis. Whereas most treatment methods limit the treatment to the nails, protecting the nail base from irradiation, the authors feel that better results are obtained when the whole hand or foot is treated. They have used this method even when the patient did not have arthritis as a complication of psoriasis—130 kv., constant potential, 4 mm. aluminum filter for the hands and 6 mm. aluminum for the feet. These treatments are usually given at monthly intervals, 300 r for each treatment. In 6 out of 24 cases treated complete remission of all changes in the nails occurred. Ten cases were markedly improved. No improvement was obtained in 2 cases. Of 9 cases with arthritis complete symptomatic relief occurred in 4 and marked improvement in four.—*Wendell C. Hall.*

EBENIUS, BERTIL. Peroral roentgen treatment of malignant tumours. *Acta radiol.*, 1941, *22*, 194–201.

In irradiating malignant tumors of the mouth and throat through the skin there is apt to be serious damage of surrounding tissues. This can be obviated, particularly if the tumors are small, by giving the treatment through a cylinder introduced into the mouth. The roentgen tube is attached to the peroral tube in such a way that the focus of the tube lies in the prolongation of the axis of the cylinder. One difficulty has been in fixation of the tube so that the irradiation is directed constantly on the tumor. This the author has accomplished by fixing the peroral tube to the jaws with dental compound. The apparatus is described in detail and illustrated.

Since 1936 about 70 patients have been treated by this method at Radiumhemmet. The tumor must be situated so that the peroral tube can be applied directly to it. As a rule, a cylinder more than 4 to 4.5 cm. in diameter cannot be introduced into the mouth, so the tumor must not be more than 3 to 3.5 cm. in diameter. Within its limitations the method is valuable because it avoids injury to normal tissue.—*Audrey G. Morgan.*

KJELLBERG, SVEN ROLAND. Radiologische Behandlung von Epuliden. (Radiation treatment of epulis.) *Acta radiol.*, 1941, *22*, 202–216.

From 1922 to 1938, 109 cases of epulis were treated at the Radiumhemmet. Of these, 82 were examined microscopically. They are divided into four groups: 13 cases were fibromatous, 15 angiomatous, 40 giant cell epulids and 12 mesenchymal without giant cells. The histopathological findings are described in detail and illustrated with photomicrographs.

Treatment was with radium in all except 4 cases in which roentgen radiation was used. The roentgen technique was 300 r per day for five days—total dose 1,500 r—with a filter of 0.5 mm. copper and 1 mm. aluminum, voltage 170 kv. The radium treatment was either teleradium, brachyradium, implantation of radium needles into the tumor or superficial application of radium tubes or needles, the technique being varied according to the requirements of the case.

Among these cases 59 have been well and free of symptoms for more than five years, 15 of them for more than ten years. There was recurrence in only 9 cases. Five of these were of the angiomatous type and 3 of a type that varied from the structure of the groups to which they belonged. This variation in histological structure may have had something to do with their lack of radiosensitiveness.

Of the 15 patients with angiomatous epulis 14 were women; in 9 of these the epulis developed in connection with pregnancy and in 1 during lactation. Among the 5 cases of recurrence of angiomatous epulis 4 occurred during pregnancy and 1 during lactation. This suggests that they were probably caused by disturbances of sex hormone function.—*Audrey G. Morgan.*